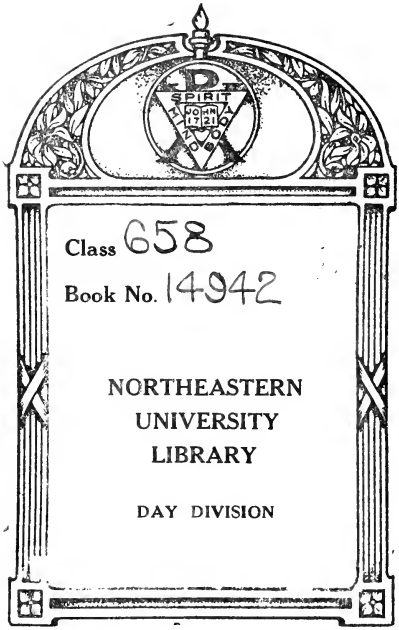
SCIENTIFIC MANAGEMENT
IN
AMERICAN INDUSTRY

THE TAYLOR SOCIETY



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FREDERICK WINSLOW TAYLOR

SCIENTIFIC MANAGEMENT IN AMERICAN INDUSTRY

By

THE TAYLOR SOCIETY

H. S. PERSON, EDITOR

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SCIENTIFIC MANAGEMENT
IN AMERICAN INDUSTRY

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To
MRS. FREDERICK WINSLOW TAYLOR

14942

There is no place for conflict in the economic world. . . . There is but one economic man and one group of economic forces. . . . Those who make for efficiency make also for the improvement of all other ennobling qualities.

—Simon N. Patten.

CONTRIBUTORS TO THIS VOLUME

Babcock, George D., Vice-President, Central Lumber Mills, Inc., Fletcher, N. C.

Barber, Joseph H., Assistant to the President, Walworth Company, Boston, Mass.

Brown, Ernest G., Mechanical Engineer, United States Rubber Co., New Haven, Conn.

Bruère, Robert W., Secretary on Industrial Relations, J. C. Penney Foundation; Associate Editor, *The Survey*, New York, N. Y.

Bryant, Leslie E., Assistant to Engineer, Armstrong Cork Company, Linoleum Division, Lancaster, Pa.

Burgess, Robert W., Chief Statistician, Western Electric Company, New York, N. Y.

Cherington, Paul T., Director of Research, J. Walter Thompson Company, New York, N. Y.; Professor of Marketing, Stanford University, Calif.

Cooke, Morris Llewellyn, Consulting Engineer, Philadelphia, Pa.; Past President of the Taylor Society, New York, N. Y.

Coonley, Howard, President, Walworth Company, Boston, Mass.

Dennison, Henry S., President, Dennison Manufacturing Company, Framingham, Mass.

Farquhar, Henry H., Hahn Department Stores, Inc., New York, N. Y.

Fuller, Walter D., Secretary, Curtis Publishing Company, Philadelphia, Pa.

Hathaway, H. K., Consulting Engineer, New York, N. Y.

Hunt, Edward Eyre, Secretary, President's Conference on Unemployment, Washington, D. C.

Keir, John S., Economist, Dennison Manufacturing Company, Framingham, Mass.

Lansburgh, Richard H., Professor of Industry, University of Pennsylvania, Philadelphia, Pa.

Leffingwell, William H., President, W. H. Leffingwell, Inc., New York, N. Y.

Mitchell, Thomas W., Associate Economist, Federal Trade Commission, Washington, D. C.

Perris, Norris M., Member of Firm, Stevenson, Harrison & Jordan, New York, N. Y.

Person, Harlow S., Managing Director, Taylor Society, New York, N. Y.

Rowland, F. L., Manager of Office Administration, Lincoln National Life Insurance Company, Fort Wayne, Ind.

Schulz, G. E., Consulting Engineer in Management, New York, N. Y.

Stone, N. I., Industrial Counselor, New York, N. Y.

Tead, Ordway, Editor of Economic and Business Books, Harper & Brothers; Lecturer in Personnel Administration, Columbia University, New York, N. Y.

Williams, John H., Industrial Engineer, New York, N. Y.

Yoakum, C. S., Dean of the College of Liberal Arts, Northwestern University, Evanston, Ill.

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FOREWORD

This exposition of scientific management as a project of the Taylor Society was conceived and carried through to completion of the manuscript during the incumbency of my predecessor, Morris L. Cooke, as president of the Society. However, the processes of manufacture have made the actual publication an event of my administration, and I am pleased that these circumstances permit me to incorporate a note of congratulation for an undertaking so admirably conceived, organized, and worked out in detail by those who have participated in its construction. The Society is particularly indebted to those who, although neither officers nor employees, have given so generously of their experience and thinking—and of their time.

It is an interesting coincidence, not perceived, I am advised, at the inception of the project, that this work is an epitome of the first decade of organized effort of the Taylor Society. Although more than twenty years old—exact dates are not possible, for the Society began as informal meetings, without records, of a group of a dozen men—the Society did not establish an office and staff of workers until 1919. Since then its principal objective has been to interpret and expound scientific management in its applications and reactions to a changing environment. This book is a summary of a decade's study, analysis and exposition of the philosophy, principles and procedures of scientific management; and a picture of its status and influence today.

BOSTON, MASS.,
September, 1929.

HENRY P. KENDALL,
President of the Taylor Society.

PREFACE [1]

THIS book has been designed to meet the increasing demand on the Taylor Society for a comprehensive treatise on scientific management. No such treatise exists. The Taylor, Gantt and Gilbreth classics were either for special audiences or treated of special phases. It is also true that all books in this field written before the Great War were addressed to those who needed to be convinced as to the basic soundness of a philosophy rather than to those who, having accepted that philosophy, desire to know more of the technique and extent of its application.

Our purpose has been to give a perspective, a rounded-out picture of scientific management, and further to have this largely a post-war characterization showing the adaptations suggested by this school of industrial thought and procedure in meeting the various situations which have confronted American industry since the armistice. Scientific management covers a field too broad to be compassed in a single volume, but it has been our aim to lay the foundation in this book along such fundamentally sound lines as might well pave the way for subsequent books treating special aspects in detail.

This work was undertaken as a project of the 1928 program of the Taylor Society, and the outline was prepared by Dr. Harlow S. Person, our Managing Director. The analysis on the basis of the three outstanding elements—research, standardization and control through standards—is altogether novel and illuminating. The text includes the work of more than a score of authors. The disadvantage of such multiple authorship is obvious—loss in logical details, in unity of treatment and in conformity of style, although these have been reduced by painstaking planning. But there are compensating advantages. Because no single volume on such a broad subject can in any real sense be inclusive, the test must rather be that of suggestiveness. Multiple authorship makes possible illustrations out of a much wider variety of the industries which have come under the influence of scientific management as well as a wider range of functions to which scientific management has been applied. The very flexibility and individuality of development inherent in multiple authorship has advantages also in arousing and holding the reader's interest, and this without any sacri-

[1] By Morris Llewellyn Cooke, Past President of the Taylor Society.

fice of essentials. Had any two authors exchanged authorship of chapters, such chapters would in treatment, illustrations and other superficial aspects have been quite different from what they now are; yet the philosophy, approach and basic technique would necessarily have been much the same.

The time is past of course when any one individual can cover the whole of industry as a master. But for this present volume we have succeeded in securing as authors for the various chapters those who can easily qualify as experts as to the matters about which they have written. The extent to which the application of scientific management has progressed among the industries of this country is evidenced in the list of contributors both by the variety in functional approach and by the number of different industries represented.

There are many ways in which the importance of the work of Frederick W. Taylor, the "Father of Scientific Management," can be assessed. The America of the late 'seventies and early 'eighties, the period when Taylor first came on the industrial scene, was gripped in a vicious circle of low wages, low production, low purchasing power and a consequent lack of prosperity. Strikes and other evidences of widespread industrial unrest marked the period. My own experience as a workman with the monotony and lack of outlook of the machine shop of the middle 'nineties has given me a very real sense of the meaningful and fundamental break Taylor made with the past. Standing alone—for he was the spokesman for no group and represented no special interest—he projected into this drab milieu his program of high wages for the individual as the reward for high production by that individual; and pragmatist that he was, he taught the individual and society how exceptional production could be secured. With vivid practical applications made possible by detailed and long-continued researches, backed by a gripping personality, he won acceptance for his thesis that the warfare between employer and employee, between the manager and those whose work he directs—incessant since the early days of the Industrial Revolution—is for the most part wanton waste. The commonly accepted doctrines of high reward for high performance, and so of actually lowering costs through paying higher wages, he was the first to propose. And thus there was initiated on a firm technical foundation the typically American policy of the maintenance of purchasing power.

But the fact that he instilled a priceless optimism into industry, and therefore into life, constitutes in my opinion his chief claim to our gratitude. He desired most of all to make industry lightsome, something after the order of a game. He constantly deprecated the fact that the technique and the ethics and the spirit of the ball field were foreign to the factory. In his mind nothing in industry need be static,

not even wages, and further, nothing need be drab. Over and over again he proved that even menial tasks after scientific analysis demand the service of experts for their execution, and that there is no detail in the industrial process which is not capable of almost indefinite exploration if we can but get that point of view.

Without the slightest thought of abandoning anything that is vital in authority—the authority which grows out of responsibility—Taylor did try, and try with no small measure of success, to get everybody effectively and sympathetically into the play. Quite early in his career he took the fateful step referred to by Chesterton "of deciding, in the face of many serious dangers and disadvantages, to let everybody talk." In varying degree the open forum has been characteristic of scientific management in the shop and in public discussion.

From all this has sprung a philosophy and technique of purposeful activity which has gripped the imagination of the world. Taylor's books have been translated into many foreign languages and in some countries have run into very large editions. An entire new literature has come into being covering the conduct of industry according to standards which Taylor set up. The International Management Institute in Geneva, a child of the International Labor Office, itself the creature of the League of Nations, has been instituted to promote these ideas through world-wide publicity. And in June, 1929, the Fourth International Scientific Management Congress met in Paris—the earlier ones having been held at two-year intervals in Prague, Brussels and Rome. And so, to pass on not a finished product but a vibrant, growing, exhilarating industrial practice for development and refinement in our throbbing present-day experience, is the object of this book.

The Taylor Society, speaking for itself as well as for all those who will ultimately profit by this cooperative undertaking, expresses its grateful appreciation to those who have contributed so generously of their time and talents. It is appropriate that special mention be made of the guiding hand Dr. Person has played from start to finish. A teacher, skilled expositor and able administrator, both by aptitude and life-long experience, and for many years one of our most astute students of the scientific management movement, he came to the task of both author and editor with an equipment that left nothing to be desired.

PART I

INTRODUCTION

A journey of a thousand miles begins with a single step.

—Chinese Proverb.

SCIENTIFIC MANAGEMENT IN AMERICAN INDUSTRY

CHAPTER I

THE ORIGIN AND NATURE OF SCIENTIFIC MANAGEMENT [1]

FIFTY years ago Frederick W. Taylor at the age of twenty-two secured a job as yard laborer at the Midvale Steel Company, Philadelphia. Within six years he had become chief engineer of that plant. Such progress is in itself indicative that unusual ability had found its opportunity. But what is indicative that constructive genius had found its opportunity is the fact that during the same six years this young man had conceived and laid the foundations of that scientific management which was to become a force of world-wide influence.

The young man had prepared to enter Harvard University for study of the law, but impaired vision compelled him to forego a career which involved much reading. His restless energy would not permit him to live idly at his parents' home, so he, at the age of eighteen years, began apprenticeship as machinist and pattern-maker in a small shop in Philadelphia. Having completed that training he sought a position at the Midvale Steel Company. Because business was not good and skilled labor was not in demand, he had to be satisfied at the beginning with a yard laborer's job. But nature had predetermined that he should not long remain at such a task, for he was a bundle of vitality—energetic, persistent, curious, open-minded, bold, inventive and disposed to experiment. Soon he was made a gang boss—an assistant foreman—supervising a group of men working chiefly on lathes.[2]

Immediately he was plunged into difficulties of management. The output was low and, having been a worker among workers of that day, he knew it was due to systematic as well as unconscious soldiering. He

[1] By Harlow S. Person, Managing Director of the Taylor Society, New York.

[2] For details of Taylor's life and of the origins of scientific management, cf. *Frederick W. Taylor: Father of Scientific Management*, by Frank Barclay Copley. New York, Harper & Brothers, 1923.

not unnaturally imitated the methods of foremen under whom he had worked and attempted to force production by driving the workers, the method of foremanship then customary. A bitter fight with his men resulted. Young Taylor won out, but the experience hurt what was a sensitive and sympathetic nature and disillusioned him. "I was a young man in years, but I give you my word I was a great deal older than I am now, what with the worry, meanness and contemptibleness of the whole damn thing," he said many years later; "I made up my mind either to get out—or to find some remedy for this unbearable condition." [1]

The youthful foreman did some hard thinking and decided that under the circumstances the attitude of the men was not unnatural—perhaps not unreasonable—and that management was chiefly at fault. At that date mechanization of industry was well under way, operations were becoming specialized, workers at machines were more scattered and more difficult to supervise, and planning, supervision and coordination had not developed with specialization. Experience with unemployment during the 'seventies had convinced workers that there was not enough work to go around, experience with the cutting of piece rates had caused distrust of management, and generally, morale and voluntary effort were low. Throughout American industry management's concept of a proper day's work was what a foreman could *drive* workers to do, and the workers' conception was how little they could do and hold their jobs.

But, reasoned the young Taylor, it is management's business to *know* what is a proper day's work. The only way to know is by research and experiment. Thereupon he requested and secured permission to conduct "some experiments." He did not think they would take over six months, but they continued more than twenty-five years. Almost immediately, however, they yielded results in the nature of measured procedures and possibilities of work which put supervision and management of his gang, and later of the entire shop, on a *factual* basis. The body of interlocking procedures which resulted from these investigations came to be known as the "Taylor System," and to the doctrine and principles later derived from them was given the name "Scientific Management." [2]

The Taylor System. The extent to which conditions favored Taylor's first experiments has never been appreciated. In the first place, his chief, William Sellers, was one of America's great engineers and

[1] Copley, *op. cit.*, I, p. 5.

[2] The term "Scientific Management" was adopted by a group of engineers called in conference late in 1910 by Louis D. Brandeis, then an attorney for the shippers in the Eastern Rate Case hearings, now an Associate Justice of the Supreme Court of the United States.

sympathetic with research. Taylor did not have to plead, make visionary promises, or even explain his purpose, in order to secure permission to undertake the experiments. In the second place, his machines were working chiefly on heavy products, locomotive drive-wheel tires and locomotive axles, in which the total operation times are long, and the units of these distinct and measurable. Perhaps if he had been compelled at the beginning to experiment on machines working at high speed on small products, he might have encountered difficulties which would have discouraged him and caused him to discontinue the experiments. Circumstances permitted him to master a technique of controlled experiment on relatively simple operations before he was confronted later at Bethlehem and elsewhere by problems of more minute measurement which, with the genius of Carl G. Barth available, he was then able to master.

He withdrew a machine and skilled worker from productive operations, appropriated a large stock of waste steel in the yard, and began the experiments. He had the ability to acquire very soon the truly scientific method—to hold all variables constant except that at the moment under observation, and to control variation of that. He studied variations in the condition of shafting, belting,[1] speeds of the machine, shape and temper of the tools,[2] feed of the tool into the material being cut, composition, preparation and availability of materials, methods and motions of the worker, and so on. His primary purpose was to discover best conditions of the use of facilities. He soon discovered for each operation a standard combination of elemental conditions which, if established and maintained during an operation, would permit increases in output amounting in some instances to several hundred per cent, not only without adding to the fatigue of the worker but with actual diminution of fatigue, for the same reason that a professional possessing correct form, skill and tools becomes less fatigued than the awkward amateur.

The principal point of view from which he considered the effect of every change in a variable was the length of time it took to perform an operation, quality of product according to specification being always a condition precedent to the recording of these time data. Time being such an important factor in cost generally, any condition which resulted in diminution of time was considered an improved condition. For instance, a belting tension which delivered 75 per cent of the shaft power

[1] "Notes on Belting" (1893), a by-product of these experiments, remains an authoritative monograph.

[2] "On the Art of Cutting Metals" (1906), is the report of researches which continued for over fifteen years and revolutionized the metal-cutting industry. Taylor said they "were undertaken to obtain a part of the information necessary to establish in a machine shop our system of management."

to the machine was a better condition than one which delivered only 50 per cent of the power, as evidenced by the greater output per unit of time. The stop watch was the instrument by which times were measured, and the elements of an operation were measured (unit time study) instead of the operation as a whole (overall time study).[1]

It was not until later in other plants involving such conditions as heavy lifting, speedier machines and concentrated attention[2] that it became necessary to consider fatigue effects as of equal importance to time reduction, for at Midvale fatigue did not emerge as a problem. As has been stated, the operations at Midvale were concerned with machining huge parts in which workers' handling time was a minor fraction of the machine time, and in which therefore the long machine time, during which the worker was relatively idle, automatically provided a large margin for any fatigue resulting from handling conditions and methods. This is why little attention was given to fatigue in Taylor's early writings; circumstances did not bring it to attention.

Gradually Taylor developed a procedure of utilization of the information thus acquired, this procedure constituting the system of management which industry later came to identify by his name. This procedure was a growth, a product of trial and of evolution of the workable, and the chronological steps of development did not coincide completely with the logical steps. Yet the logical steps give a fair and informing picture of the evolution.

1. *Experiment.* The first step of managerial procedure which he developed was continuing experiment—measurement, classification and filing of the results. Every operation was studied, and then restudied as new materials, machines, appliances, tools and skills became factors. Research, although not to the outside world the most conspicuous, became the *basic element* of Taylor procedure; and it should be noted that this research, although in many instances inspired by interest in pure science, was motivated primarily by the desire to discover the laws of manufacturing economy.

2. *Standards.* The second step of procedure was the formulation of the laws of manufacturing economy in the form of standards of facilities and of individual and cooperative conduct. Specifications of materials and materials handling, machines, machine adjustments for each operation, proper tools for each operation, times for each operation—even the best type of worker for each operation—were made common information in standing orders, special orders, drawings, lists of materials, instruction cards and similar documents. The purpose of publi-

[1] Cf. Chapter VII for details of shop research.

[2] Cf. *The Principles of Scientific Management*, for cases relating to handling pig iron, shoveling and inspection of balls for bearings.

cation of these standards was to establish certainties in the place of variability and guess as a basis for calculation in industrial operations.

3. *Planning of Work.* The third important step was to develop elements of procedure which were the most visible because it involved the most documents and attracted the most attention. This step was for many years assumed by the superficially informed to constitute the whole of the Taylor System—the systematic planning and directing of work throughout processing. This element was not as basically new as the two elements mentioned above, for managers had always to some degree planned and supervised work in process, and Taylor got many elements of his planning and control mechanism from other shops. But he integrated mechanisms into an interlocking whole, and the degree to which planning and precise control were developed by him was so great in quantity as to create a new qualitative situation. Planning generally had not been effective because it was based on so many chance factors. Now, with the aid of standardization, calculations could be made with a fair degree of certainty. This made possible the planning-room procedures of routing, scheduling and complete and economical utilization of facilities. It was this precise control through planning and preparation which secured most of the results of increased productivity by eliminating idle times and misapplied efforts, which are the result of many different causes under uncontrolled conditions.

4. *Maintenance of Standards.* The fourth significant step was the development of procedures for systematic inspection of conditions and performance, for the purpose of maintaining the established standards upon which precise planning and control were based. The operations of an enterprise are the affairs of normal human beings and are subject to all influences of human nature—misunderstanding, inertia, inhibitions, carelessness, laziness. Training to do things according to a newly discovered "best way in the present state of the art," is a condition of learning with all the backslidings that result from the struggle between old and new patterns of conduct. A man may resolve to do a piece of work in a newly discovered best way with all the enthusiasm with which he resolves to grease and oil his new automobile precisely as set forth in the instructions; but six months later performance has declined from high resolve as badly in the one case as in the other—and for the same reasons. Therefore Taylor incorporated a system of inspection of materials, methods and costs into his general system of planning and control, utilizing for this purpose the identical documents used in the planning and control procedures.

Such were the main characteristics of the system worked out in embryo, yet completely in principle, at Midvale in the early 'eighties and

developed under more complicated conditions during the next fifteen years at Bethlehem and elsewhere. But this should be noted: our analysis is that of the commentator of 1929; not of Taylor himself. During the early period of development of his system Taylor made no public statement concerning the nature and significance of his system of management; he was simply a practical executive—gang boss, foreman, assistant engineer, chief engineer—solving in a practical and logical manner the day's managerial problems as they came along. It was not until 1895 that he prepared his first paper on management—"A Piece-Rate System"—under the stimulus of discussions at meetings of the American Society of Mechanical Engineers. And when he did get into these discussions his analysis took the form not only of descriptions of mechanisms and procedures, but also of broad generalizations which fifteen years later came to be identified by the term "Scientific Management."

Scientific Management. At the same time that Taylor was conducting his researches and developing his methods at Midvale and Bethlehem, the "management movement" in American industry was getting well under way. A convenient milestone to mark the beginning of this movement was Henry R. Towne's classic paper, "The Engineer as Economist," presented at a meeting of the American Society of Mechanical Engineers in 1886.

It was on the forum offered by the recently organized American Society of Mechanical Engineers that the management movement had its beginning, for there were no other available fora, such as management societies, business men's associations and manufacturers' associations, in the United States at that time. It was the engineers' forum which enabled industry's growing consciousness of management problems to become articulate. It was natural for other reasons that the engineers should begin the public discussion of management, for the most pressing of the managerial problems then developing were those of coordination and supervision of workers scattered among the new equipment being installed by them in the larger plants. The engineers were not only the inventors, designers and producers of the new equipment, but also installers and quasi-executives responsible for getting the new machines into operation. It was inevitable therefore that owners should turn to them for solution of the managerial problems created by the new mechanization of industry.

The principal characteristic of the discussions which took place at engineering meetings and in engineering journals [1] during the fifteen

[1] *Transactions of the American Society of Mechanical Engineers* and *The Engineering Magazine* are a mine of information concerning the management movement at its inception and for a period of twenty-five years.

or twenty years following Towne's address, is that generally they did not conceive management as an integral problem, but as a succession of isolated problems; and that they assumed that conditions must be accepted pretty much as they exist by chance. The concept that a day's work could be measured and predetermined did not occur to them, and when suggested by Taylor was summarily dismissed. Roughly the discussions at first emphasized differential wage systems [1] (apparently a search for incentives as a substitute for the effective supervision which had been characteristic of the earlier small shop), then cost systems (apparently an effort to measure the relative values of different kinds of incentive wage systems), and then organization and system (apparently a recognition that, as a result of cost measurements, the nature of an organization and the system of execution has much to do with the results of any wage system). There were only scattered and ineffectual attempts to analyze management as a complex of related problems to be solved by a complex of related procedures.

Taylor, who joined the A. S. M. E. in 1885, listened to these discussions with a growing impatience. They ignored the point from which he had started at Midvale—the necessity of measurement and understanding of a proper day's work for every operation. So he decided to present a paper, and in order to have it accepted as pertinent to the problem of dominant interest he made it an exposition of a method of wage payment which he had devised.[2] But his real intention was to cloak under discussion of that subject an argument concerning the necessity of measuring performance as the essential basis for any system of wage payment. His piece-rate system was discussed—on the whole unfavorably—but practically no attention was paid to his concept of the measurement and control of a day's work. This concept was ignored apparently as impracticable. He thereupon decided to present another paper which should be an outright discussion of management, and in 1903 he offered "Shop Management." The discussion of this paper also failed to stimulate sympathetic interest in the idea that a day's work could be measured. It was not until eight years later, at the Eastern Rate Case hearings of 1910-1911 which gave Taylor ideas a sudden vogue under the name of "Scientific Management," that critical analyses of his doctrine and methods were forthcoming.

Taylor was an engineer-executive, who had neither the inclination nor the time for much writing. His papers were prepared for special audiences of engineer-executives. Therefore we do not find in his expositions that completeness of thought and logical arrangement to which we are accustomed in treatises by men who write frequently and

[1] The Halsey, Rowan, Towne-Halsey and similar systems were devised at this time.
[2] "A Piece-Rate System," 1895.

for students at large. His several statements of principles are as follows, and they show his growth in breadth of vision and capacity for generalization as he came to be the central figure in the management movement.

In "A Piece-Rate System" (1895) [1]

In this paper a categorical statement of principles was not attempted. Although he explained his differential piece-rate scheme, and compared it with the ordinary piece-rate, gain-sharing, premium and profit-sharing schemes, he sought to emphasize particularly his "elementary rate-fixing department"—its research and consequent standardizing of conditions. In his closure he expressed the regret that "the elementary rate-fixing has not received more attention during the discussion." In the introduction to the paper is a summary of conclusions, of which the most important are the following:

1. Wages should be paid to men, not to positions.
2. Rate-fixing should be based on accurate knowledge, not guess.
3. Rates based on exact observation are more uniform and just.
4. With rates so established, "manufactures are produced cheaper . . . while at the same time the workmen earn higher wages than are usually paid."
5. Wages based on exact knowledge develop better workmen, permit them to earn higher wages, remove motives for soldiering, promote a friendly feeling between the men and their employers; and create "a common interest of both the management and the men to cooperate in every way."

In *Shop Management* (1903) [2]

The writer has already indicated that he thinks the first object in management is to unite high wages with low labor cost. He believes that this object can be most easily attained by the application of the following principles:

a. A large daily task. Each man in the establishment, high or low, should daily have a clearly defined task laid out before him. This task should not in the least degree be vague nor indefinite, but should be circumscribed carefully and completely, and should not be easy to accomplish.

b. Standard conditions. Each man's task should call for a full day's work, and at the same time the workman should be given such standardized conditions and appliances as will enable him to accomplish his task with certainty.

c. High pay for success. He should be sure of large pay when he accomplishes his task.

d. Loss in case of failure. When he fails he should be sure that sooner or later he will be the loser by it.

When an establishment has reached an advanced state of organization, in many cases a fifth element should be added, namely: the task should be made so difficult that it can only be accomplished by a first-class man.

In *The Principles of Scientific Management* (1911)

1. In the Text [3]

These new duties are grouped under four heads:

First. They develop a science for each element of a man's work, which replaces the old rule-of-thumb method.

[1] *Transactions of the American Society of Mechanical Engineers,* Vol. XVI, 1895, pp. 856-858.

[2] Pages 63 and 64, Harper edition.

[3] Page 36, Harper edition.

Second. They scientifically select and then train, teach and develop the workman, whereas in the past he chose his own work and trained himself as best he could.

Third. They heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.

Fourth. There is an almost equal division of the work between the management and the workmen. The management takes over all work for which they are better fitted than the workmen, while in the past almost all the work and the greater part of the responsibility were thrown upon the men.

2. In a Footnote [1]

Scientific management, in its essence, consists of a certain philosophy, which results, as before stated, in a combination of the four great underlying principles of management:

First. The development of true science.

Second. The scientific selection of workmen.

Third. Their scientific education and development.

Fourth. Intimate friendly cooperation between the management and the men.

In "Hearings Before Special Committee of the House of Representatives. . . ." (1912)[2]

Scientific management is not any efficiency device, not a device of any kind for securing efficiency; nor is it any bunch or group of efficiency devices. It is not a new system of figuring costs; it is not a new scheme of paying men; it is not a piece-work system; it is not a bonus system; it is not a premium system; it is no scheme for paying men; it is not holding a stop watch on a man and writing things down about him; it is not time study; it is not motion study nor an analysis of the movement of men; it is not the printing and ruling and unloading of a ton or two of blanks on a set of men and saying, "Here's your system; go use it." It is not divided foremanship or functional foremanship; it is not any of the devices which the average man calls to mind when scientific management is spoken of. The average man thinks of one or more of these things when he hears the words "scientific management" mentioned, but scientific management is not any of these devices. I am not sneering at cost-keeping systems, at time study, at functional foremanship, nor at any new and improved scheme of paying men, nor at any efficiency devices, if they are really devices that make for efficiency. I believe in them; but what I am emphasizing is that these devices in whole or in part are not scientific management; they are useful adjuncts to scientific management, so are they also useful adjuncts of other systems of management.

Now, in its essence, scientific management involves a complete mental revolution on the part of the workingman engaged in any particular establishment or industry—a complete mental revolution on the part of these men as to their duties toward their work, toward their fellow men, and toward their employers. And it involves the equally complete mental revolution on the part of those on the management's side—the foreman, the superintendent, the owner of the business, the board of directors—a complete mental revolution on their part

[1] Page 130, Harper edition.

[2] Reprinted in *Bulletin of the Taylor Society,* Vol. X, No. 3, June-August, 1926, pp. 102, 103, 104.

as to their duties toward their fellow workers in the management, toward their workmen, and toward all of their daily problems. And without this complete mental revolution on both sides scientific management does not exist.

The substitution of this new outlook—this new viewpoint—is of the very essence of scientific management, and scientific management exists nowhere until after this has become the central idea of both sides; until this new idea of cooperation and peace has been substituted for the old idea of discord and war.

We observe in these statements, representing a period of seventeen years between the first and the last, a variation in emphasis according to the particular audience and its particular interest at the time. Had Taylor lived to witness the profound changes in social and industrial conditions which have developed since his death in 1915, and the new emphasis on values in appraising conduct in industry, he would without doubt today present a new analysis of principles as far in advance of those of 1911 and 1912 as those were in advance of the earlier systematic analyses.

In these various statements the substance of a logical and inspiring set of principles is to be found. The critical analyst of today, objectifying them and the practices from which they were derived, has but to recast them in a new perspective. The present author is accustomed to present the principles in the form given below. This is based on analyses of the Taylor system as designed by Taylor and as it has developed under modern conditions, on Taylor's published statements concerning scientific management, and not least, on his unpublished explanations and exhortations to those young men who were associated with him in his work. It adds nothing new to the content of scientific management as explained by him, and is different only in its later perspective and in its arrangement and emphasis to answer the dominant questions of 1929.

A 1929 Statement of Principles. 1. *Management Research.* Research, investigation and experiment (with their processes of analysis, measurement, comparison, etc.) constitute the only sound basis for the solution of managerial problems; for determinations of purpose, policy, program, project, product, material, machine, tool, type of ability or skill, method and other factors, and the coordination of these in purposeful effort.

2. *Management Standards.* To make them useful to an enterprise, the results of research, investigation and experiment must be made available to the cooperating group in the form of defined and published standards which serve as common goals, facilities and methods, and which replace chance and variable factors by constants in terms of which may be made calculations and plans which may be expected to come true.

3. *Management Control.* There must be established a systematic procedure, based on the defined standards, for the execution of work; a procedure which directs the researches, establishes and maintains the standards, initiates operations and controls work in process; which facilitates each specialized effort and coordinates all specialized efforts, to the end that the common objective may be achieved with a minimum of waste of human and material energies, and with a maximum of human welfare and contentment.

4. *Cooperation.* Durably effective management requires recognition of the natural laws of cooperation: involving the integration of individual interests and desires with group interests and desires and of individual capacities with the requirements of group purposes; the substitution of the laws of situations for individual authority, guess and whim; and the recognition and capitalization of human differences, motives, desires and capacities in the promotion of a common purpose.[1]

It is obvious to one experienced in human affairs, and particularly in enterprises in which many types of individuality must join in common effort, that here is not an inflexible system of procedures which can be bought and installed like a boiler or a loom; that on the contrary here is something of an organic nature which, although it may be conceived and guided by an outstanding leadership, must be based on a harmony of desires and understandings within the group. That is one reason why there are so few complete developments of scientific management, even though American industry generally has been profoundly influenced by its spirit and has come to utilize practically all of its mechanisms. In the first place, most managers are reluctant, except under the compulsion of circumstances, to undertake revolutionary improvement; in the second place, because of natural basic conditions of prosperity in America, there has not been general compulsion toward ideals and methods marking a radical departure from opportunism. The urge for a consistent and well-rounded development of scientific management, as distinguished from unconscious influence of its spirit and conscious appropriation of some of its waste-saving mechanisms, has been felt chiefly by those rare leaders who are naturally responsive to ideals of perfection in technical accomplishment and in human relations.[2]

Another reason is that generally the American executive does not take to doctrines, theories or systems. He has lived in a period of opportunism, has been concerned chiefly with dynamic problems of frontier industry, and has been engaged in doing things rather than

[1] Cf. Chapter XXVIII.
[2] Cf. Chapter XXVII.

in reading and thinking about things. Doctrines and systems do not excite his interest; in fact, a new doctrine or system is likely at first to invite rejection without serious consideration. In time, however, it is almost certain to have great influence if it has integrity and vigor, for the detailed beliefs or practices expressing a doctrine may be held or practiced by individuals who do not hold or are not informed concerning the doctrine as a whole.

The Influence of Scientific Management. Appraisal of the influences of a movement is a matter of historical research, analysis and judgment. One who searches the literature of American management since its beginning will find abundant evidence that the aims, principles and procedures first presented by Taylor have, like the ripples of a stone cast into a pool, spread out into American industry, although many a management of 1929 may not know the source of that which it believes or practices.[1]

It should be noted that its influence has been enlarged and extended by supplementary forces of independent origin. Those who, reacting to the development of scientific method during recent decades, have made research and experiment the basis of the pursuit of their special interest in management—even in special fields such as employer-employee relations, merchandising or general administration—have found themselves developing techniques and expressing philosophies essentially identical with the technique and philosophy expressed by Taylor nearly half a century ago. Even the very recent developments of psychology in the field of management are more closely related to Taylor's early empirical studies of fatigue in shoveling, handling pig iron and inspecting balls for ball bearings, than to the introspective psychology which was contemporary with him. He had a vision of such things and was confident of the future. Asked why he had not turned attention to scientific management in other phases of management than production, he replied that life was too short, that the best he alone could do was to make a thorough demonstration in the field of production management, leaving to others the problem of carrying the development into other fields.[2]

In the United States there is great variety as to size of plants, nature of the processing—continuous, intermittent or variable—and as to the kind and quality of management. There is a small proportion of large mass-production establishments employing many workers and with enormous output. Some of these have been strongly influenced by scientific management, some moderately and some very little. There is a very considerable proportion of medium-sized plants, some of which

[1] Cf. Chapter III.

[2] *Bulletin of the Taylor Society*, Vol. IX, No. 2, April, 1924, p. 55.

may have continuous processing in one or more departments although they would not be classified as mass-production establishments. Many of these also have been influenced by scientific management. The dominant proportion of establishments—chiefly, although not altogether, of small size—have managements representing inherited patterns modified by casual imitation. Among all of these classes can be found only a small handful of deliberate, patient, well-rounded developments of scientific management.[1]

A large number of plants dominated by tradition and imitation has naturally appropriated some of the mechanisms of scientific management, and although the net result has been a gradual raising of the level of management in such plants, this result has not been achieved in all cases. Very serious damage in individual instances to managerial effectiveness and harmonious relations with workers, and to the good repute of scientific management, has resulted from failure to adopt ideals and spirit along with mechanisms. It is in this class of plants that the superficial "efficiency engineer" has found his clientele, and as he has not hesitated to seek the advantage of proclaiming himself a representative of scientific management, the harm he has been able to bring temporarily to the repute of scientific management has been considerable. But American managements are becoming more discern-

[1] The literature of management has so featured interesting cases of mass production that many students have received the impression that American industry is made up of "Fords." The following data will be enlightening. Of establishments having an annual product of more than $5,000, the distribution in 1925 was as follows (*Statistical Abstract of the United States,* 1925):

Classes By Value of Product	Per cent of Establishments	Per cent of Workers	Per cent of Total Product
$1,000,000 and over *	5.6	56.8	67.6
500,000 to 1,000,000	5.2	13.5	11.0
100,000 to 500,000	22.5	20.0	15.3
20,000 to 100,000	36.8	7.9	5.2
5,000 to 20,000	29.8	1.9	1.0

And from the United States Census of 1919: Classes by Number of Wage Earners	Per cent of Establishments	Per cent of Workers
1 to 5 wage earners	56.2	3.3
6 to 20 wage earners	22.2	6.8
21 to 50 wage earners	10.0	8.9
51 to 100 wage earners	4.9	9.6
101 to 250 wage earners	3.9	17.3
251 to 500 wage earners	1.4	13.7
501 to 1000 wage earners	0.6	13.2
Over 1000 wage earners*	0.4	26.2

* The enterprises which an American would classify as representative of mass production are to be found in the upper strata of those classes identified by an asterisk.

ing, discriminating and cautious, and the baneful influence of the efficiency engineer appears to be declining.

Mechanization and Mass Production. The related phenomena of mechanization and mass production, so characteristic of American industry during the past quarter century, and so economical in the production of large quantities of identical items, should not be confused with scientific management. Scientific management, mechanization and mass production may coincide, but they are not identical things. Where they are found together the results are noteworthy; but too frequently where mass production and a high degree of mechanization dominate a scene, scientific management is conspicuously absent. Mass production has its origin in large markets, a huge volume of orders, standardized products and the possibility of economical fabrication by means of a steady flow of materials through single-purpose machines and highly routinized workers; and these factors are not infrequently accompanied by some degree of monopoly advantage. In such cases an enterprise may be highly successful by pursuing lines of least resistance which do not include scientific management.

In contrast to mass production, scientific management had its origin in small and medium-sized plants which make variable items, or standard items variable as to detailed characteristics, on multiple-purpose machines which require human regulation and attention as work varies. While mass production makes its gains almost entirely by the economies of a ceaseless flow of material through specialized machines, scientific management makes its gains chiefly by eliminating the waste of unsuitable equipment, misused materials, misapplied individual effort, and lack of coordination of efforts where variability is present. Both mass production and scientific management use equipment which is scientifically designed; but scientific management is a mode of using equipment which is scientifically designed.

Rationalization. Nor should rationalization be confused with scientific management. Although the former, a post-war German concept, is tending to accept *in toto* the technique of the latter, in historical origin they are distinct institutions. As has been indicated, scientific management had its origin in an attempt to solve the managerial problems of the individual plant, and its first form was that of a practical technique. It was not until later that principles were generalized from the technique and these further generalized into a doctrine. In contrast rationalization first took the form of an emotional, doctrinaire urge to organize reconstruction of an industrial society disorganized by war. It did not at first have a technique other than the general procedure, suggested by the cartel, of a "rationing" of output to keep it within

the limits of market demands, and a "rational" combination and adjustment among industries and enterprises on a national scale for the purpose of strengthening a national economy disorganized by war. Later, recognizing that the internal economy and efficiency of individual plants as well is involved, it looked around for a suitable technique and is adopting that of scientific management.

We can give our readers no better definition of rationalization than that of Oliver Sheldon:

> Rationalisation is the process of associating together individual undertakings or groups of firms in a close form of amalgamation, and, ultimately, of unifying, in some practicable degree of combination, whole industries, both nationally and internationally; with the allied objects (beyond what is possible to an industry divided into many competitive units) of increasing efficiency, lowering costs, improving conditions of labour, promoting industrial cooperation and reducing the wastes of competition, these objects being achieved by various means which unification alone makes in full measure available—the regulation of the production of an industry to balance the consumption of its products; the control of prices; the logical allocation of work to individual factories; the stabilisation of employment and regularisation of wages; the standardisation of materials, methods and products; the simplification of the ranges of goods produced; the economical organisation of distribution; the adoption of scientific methods and knowledge in the management and technique of trades as a whole; and the planning and pursuit of common-trade policies.
>
> Or, to use the terms already employed in this discussion, rationalisation is that form of industrial combination which is undertaken with the object of widening the scope for the application of scientific management to the extent of whole industries, and achieving the benefits to producers, consumers and the community which scientific management conducted on this scale alone can provide. In a word, rationalisation is not combination, nor is it scientific management; it is, rather, a form of the one with the object of the fullest extension of the other.[1]

Starting from opposite poles scientific management and rationalization are apparently moving each toward the other. With a background of experience with state socialism, the latter thought first in terms of socially controlled reorganization of all industry and then of scientific management of the particular situation. Scientific management, on the other hand, with its background of extreme individualism, started with the problem of the individual plant, then proceeded to application of its principles and technique to the management of groups of plants under one ownership. Socially it has developed the concept of volun-

[1] "What is Rationalisation?" in *Industrial Welfare* (London), March, 1929, p. 85. Cf. also for articles by other writers: *The Economic Journal*, (London), December, 1927; *The Harvard Business Review*, January and April, 1928; *Bulletin of the International Management Institute*, January, 1929; *Factory and Industrial Management*, January, 1929.

tary trade standardization. Ultimately, although probably still with individualistic bias, it may in America come to be applied to the organization and control of entire industries and all industry.

Human Relations. The concern of scientific management for harmonious industrial relations, and workers' prosperity and good-will, has always been deep, for one of the first discoveries of research in management is that good-will is a productive power independent of the efficiency of equipment and methods, and adds to the efficiency of equipment and methods. But scientific management considers workers' welfare and good-will, not as something detached which can be generated effectively as a thing apart from the spirit and methods of management, but as something which is a consequence of and integral with these. Good management and workers' welfare are the two terms of an equation; it matters little which term is put first.

The lines are many along which scientific management contributes to workers' welfare and good-will, and to harmonious industrial relations. The entire list enumerated below can be achieved only by a management of superlative vision, understanding and leadership ability, yet the total group of items in the list is true of some enterprises, and many enterprises have achieved a greater or less proportion of them according to the capacity for leadership and cooperation present in both the management and the workers in particular instances. Scientific management aims:

To gauge industrial tendencies and the market [1] in order thereby to regularize operations in a manner which will conserve the investment, sustain the enterprise as an employing agency and assure continuous operation and employment;

To assure the employee not only continuous operating and employment by correct gauging of the market, but also to assure by planned and balanced operations a continuous earning opportunity while on the payroll;

To earn, through a waste-saving management and processing technique, a larger income from a given expenditure of human and material energies, which shall be shared through increased wages and profits by workers and management;

To make possible a higher standard of living as a result of increased income to workers;

To assure a happier home and social life to workers through re-

[1] Where there are huge investments of capital in fixed and specialized form this may mean a consideration of social desirability, or long-run fundamental usefulness, as bearing on long-run demand.

moval, by increase of income, of many of the disagreeable and worrying factors in the total situation;[1]

To assure healthful as well as individually and socially agreeable conditions of work;

To assure the highest opportunity for individual capacity through scientific methods of work analysis and of selection, training, assignment, transfer and promotion of workers;

To assure by training and instructional foremanship the opportunity for workers to develop new and higher capacities, and eligibility for promotion to higher positions;

To develop self-confidence and self-respect among workers through opportunity afforded for understanding of one's own work specifically, and of plans and methods of work generally;

To develop self-expression and self-realization among workers through the stimulative influence of an atmosphere of research and valuation, through understanding of plans and methods, and through the freedom of horizontal as well as vertical contacts afforded by functional organization;

To build character through the proper conduct of work;

To promote justice through the elimination of discriminations in wage rates and elsewhere;

To eliminate factors of the environment which are irritating and the causes of frictions, and to promote common understandings, tolerances and the spirit of team work.

These aims—some of them results of early experience with scientific management which have been adopted as the aims of subsequent activity—have not been achieved with equal success in all scientific management plants, and are not the exclusive possession of that group of plants which are consciously inspired by the ideals of scientific management. But the literature of scientific management reveals that these have consistently been its aims; most of them from the beginning of the movement, and others as experience has disclosed their importance and practicability. Scientific management has always been progressive in its concepts of the solution of the problems of industrial relations. Investigation and comparison of plants reveal that generally the more complete the development of a technique of scientific management, the more completely are these aims represented in policy and procedures, and the more favorable the response of workers. The reason for this correlation is not difficult to understand. Scientific man-

[1] Says an exponent of scientific management concerning his group of seven mills: "While not unmindful of the importance of stability that is coupled with material success, their interest is quite as much in producing better citizens as in securing profits." *Bulletin of the Taylor Society*, Vol. XII, No. 6, December, 1927, p. 525.

agement requires and seeks and, the more completely it is developed in a plant, realizes a stability of conditions and sureness and economy of effort which are impossible without simultaneous development of the good-will and cooperation of the workers. Its procedures are procedures of good-will and cooperation, of which the achievement has consistently been an objective of managements inspired by the Taylor doctrine.

Scientific Management and Organized Labor. Entirely distinct from the reactions of those special groups of workers employed in scientific management plants, and chiefly representing the reactions of organizations of labor not strongly represented in such plants to scientific management as an abstract theory, was the opposition of nationally organized labor for a period following the Eastern Rate Case hearings in 1910-1911. This opposition fortunately has now practically disappeared and can be analyzed as are other historic events.

Scientific management came to public attention in the United States through certain hearings before the Interstate Commerce Commission in the winter of 1910-1911. Newspapers and magazines discovered its news value and deluged the public with articles concerning it. And although organized labor had given it no attention during the first thirty years of its slow development, now that the public was becoming interested labor also became interested. It analyzed scientific management as a doctrine and found grounds for opposition. These grounds were not unreasonable inferences from the inadequate early expositions. The most important reasons for opposition, some expressed and some unexpressed, may be reduced to four:

Organized labor had had a long and hard struggle to achieve status in the face of the strong opposition of industry, and its natural assumption was that anything new originating in management and by management was for ownership's advantage and presumably to labor's disadvantage;

Assertions concerning the development of a "science for each operation" and the reduction of operating methods to easily understood instructions, caused a fear of the loss to labor of craft distinctions and of the power of labor in the possession of craft knowledge and skill;

Numerous statements concerning economies which had been effected by scientific management, especially in the nature of labor saving, called up at once the instinctive fear that a general adoption of scientific management would cause widespread discharges and unemployment:

Inadequate explanations of the use and limitations of time study, and of reasons for increase of productivity, led to an assumption that

scientific management means a speeding up, wearing out and eventual casting aside of the individual worker.

In view of the atmosphere of distrust between industry and organized labor at that time, these points of opposition were not unnatural. They were assumptions and were wrong. The replies to them were based on experience, but an experience not documented, and were unconvincing. There was no solution for the controversy in argumentation. From the point of view of the historian in 1929, it was necessary for the course of events to bring its own enlightenment through larger experience. That is what has come to pass.

The first ground of opposition disappeared during the war. Employers and leaders of organized labor laid aside their differences as they worked side by side on war committees. They learned to understand each other better as human beings and to value each other's motives. And organized labor observed that those holding the scientific management doctrine were the most consistent of all employing groups in regarding and promoting labor's interests and in desiring to conserve labor's gains after the war.

The second ground of opposition disappeared through gradual observation of the facts. "A science for each operation" does not destroy craft skill as does mechanization; it may modify its content sometimes, but as frequently gives it wider scope. Labor has observed also that the procedures of scientific management require in addition to old skills, not a few new skills and particularly a distinctive skill of cooperation through understanding of purpose and methods. A scientific management plant strives to bring all workers in a craft to the level of skill of the best, and is more dependent on uniformly high intelligence, skill and perception of purpose on the part of workers than any other kind of plant.

The third ground of opposition also disappeared through observation of facts. Labor saving through better management, as distinct from labor saving by mechanical inventions—the principal technical cause of unemployment—although easily described, takes research, education and time to achieve. One can tell in one minute about a saving of labor energy which has taken months. Savings are generally by small increments through a long period and adjustments are usually effected during the period. The rate of saving rarely amounts to the normal rate of voluntary quits.[1] Scientific management may involve reassignments—and for the first time in the life of many workers

[1] The December, 1927, report of the Metropolitan Life Insurance Company, New York, of the average annual voluntary quit rate of more than 300 reporting companies is 14.9 per cent.

assignments on the basis of investigated capacity—but it does not usually involve discharge.

The fourth ground of opposition also gradually disappeared with experience. Improvement and standardization of machine conditions and of methods may or may not result in increased speed of production, or in increased speed of the operative; it depends upon the particular machine, the particular operation and the particular circumstances. It should be borne in mind that machines and operations vary greatly in the relation of workers' handling time to machine time, and that the problem of speed and of fatigue varies accordingly. In operating a power punch press, for instance, the worker is active all the time, fatigue becomes an important element of the situation, and experiment may disclose that a reduction of speed or introduction of rest periods will increase productivity; but in the operation of a large lathe the worker is but a watcher and adjuster for the major portion of his time, and increase in the speed of the machine has only remote fatigue relation to the worker. In many—perhaps most—instances, the increase of speed is merely a mathematical result derived by dividing total output into total time taken and securing a reduced average time per piece; for when conditions are improved so as to eliminate waiting and other idle time, the average time per piece may be reduced without any increase of actual speed. It has come to be understood that speed and fatigue are problems of each particular operation, and the more carefully a correct speed is sought by experiment and measurement, the more reasonable, just and permanent will be the standard of output finally adopted.

It is the judgment of many observers that the tempo of machine work is higher in the United States than in Europe. There have been no conclusive researches into the relation of speed to particular systems of management, particular methods of wage payment or particular industries. Competent observers report that tension as distinguished from deftness and speed appears to be least in the orderly environment of scientific management plants.

The opposition of leaders of labor to *bona fide* scientific management has practically disappeared, and during recent years there has been noteworthy cooperation between scientific management leaders and labor leaders.

The first striking evidence of labor's interest in good management and increased productivity was the association in 1920, as editors of a volume entitled *Labor Management and Production*,[1] of the president

[1] *Annals of the American Academy of Political and Social Science*, Vol. XCI, No. 180, September, 1920.

of the American Federation of Labor, a past president of the Taylor Society, and a past president of the American Society of Mechanical engineers, also an exponent of scientific management. A few years later labor leaders contributed to a similar volume.[1] In December, 1925, the president of the American Federation of Labor participated by a noteworthy address in a meeting of the Taylor Society,[2] and a few months later other representatives of labor participated in another meeting of that society.[3] In the spring of 1927 the Central Labor Union and Labor College of Philadelphia held a two-day conference on cooperation between management and labor in the development of better methods of production, in which scientific management engineers and executives were active participants. This led to other similar conferences under the auspices of organized labor. In the Cleveland, Ohio, ladies' garment market organized employers and organized workers have agreed upon a program involving measured standards of output, and the stop watch is the accepted instrument of measurement. On the Baltimore and Ohio, the Canadian National and certain other railroads there is organized cooperation between management and workers in the development of better methods, and the workers have on their payroll an engineer concerned with improvement of methods. Misunderstandings and disagreements concerning scientific management as a doctrine have given place to cooperative inquiry into conditions and methods of its utilization and perfection.

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[1] *Ibid.,* Vol. CXI, No. 200, January, 1924.

[2] *Bulletin of the Taylor Society,* Vol. X, No. 6, December, 1925.

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CHAPTER II

THE NEW ATTITUDE TOWARD MANAGEMENT [1]

When scientific management had at last gained general attention and interest, the observation was frequently made that it was "twenty years ahead of its time." The reasonableness of this appraisal depended upon the point of view from which the observer viewed "its time." In outlook, motive and technique, scientific management was undoubtedly years in advance of the larger part of American industry. On the other hand, there were enterprises at that time which were in their managements so superior to enterprises generally, that with respect to them it was but a response to an emerging need of industry.

It was so representative of tendencies as to make immediate response possible, even though much of this response did not identify the stimulus by name, and every response created an example which accelerated the development and influence of scientific management.

Yet the appraisal that it was ahead of its time was conscious or unconscious realization that here was a body of principles and a technique that represented something new in managerial philosophy. It is the purpose of this chapter to present briefly some of the elements of contrast between the old and the new.

The Old and the New. The contrast may be summarized in advance by the general statement that scientific management crystallized into a definite technique of management that urge toward a regimentation of managerial conduct which was being stimulated by a new environment which was less frontier and fluctuating, and more industrial and organized, than was the environment in which the dominant managerial habits of the time had been set.

During the greater part of the nineteenth century the United States was truly frontier. Exploration, discovery, appropriation, exploitation of forest, mineral and agricultural resources, and railroad construction, were the principal activities and set the mental attitude toward all activity. The purely industrial elements of economic life were concerned principally with the provision of food, clothing and shelter, and the materials and apparatus of the extractive and transportation industries. Industrial organizations and plants were small, investments of fixed capital were not great, processes were not highly

[1] By Harlow S. Person, Managing Director of the Taylor Society, New York.

mechanized, division of labor was simple, and supervision and coordination of plant operations were not difficult.

This economic activity was developed by settlers from northern Europe who had come to America with a strong philosophy of individualism which was intensified by the frontier environment. "All men are created equal," "every man is the architect of his own fortune," "to the victor belongs the spoils," "each man for himself and may the best man win," "the devil take the hindmost," were the epigrams of the time. And "the devil take the hindmost" was only relative and not so serious a matter as to create a social problem, for the hindmost generally was assured of shelter, clothing and sustenance by a generous nature. If one job gave out, some other job was available, and the problem of survival was not difficult.

This prodigality of nature made waste at that time individually profitable, although it is recognized today as socially costly. To the individual it was more profitable to fell and use the best trees, leaving the remainder to be burned or rot; to destroy whole forests to get at the rich soils underneath; to till such soils without fertilization until they were exhausted, and then to move on to other rich soils. Even in manufacturing the prices which an increasingly prosperous community was willing to pay provided a large margin of profit; and this, together with the fact that the interest of ownership was primarily in increases of capital values and in profits on the merchandising turnover, even in manufacturing, made unnecessary any concern about the efficiency of production. In short, the earlier point of view was that of enterprise as discovery, appropriation and exploitation; not as technical processing.

But during the period following the Civil War, change, which had been ever present in small increments, became so accelerated that industry was conscious of new problems which could not be resolved by old formulæ. The situation was in major—although not in minor—aspects similar to that in the United States during the present decade; and there was a similar—although not so intense—surge forward in industrial activity.

The Civil War removed a distracting political problem which had absorbed much of the energy of citizens, and left that energy free for other outlets. The technical requirements of the war had bequeathed new and greater productive capacity and especially a new command over mechanics and engineering. The rapid construction of railroads opened new areas for settlement, and offered opportunity for development of the agricultural, forest and mineral resources of the northwestern and western states.

This railroad construction had an important reaction on the young manufacturing industries of the more settled regions of the northeastern and north central states. Isolated markets became united into a national market. This had influence in stimulating not only the production of manufacturers' goods used in railroad construction and in the rapidly growing extractive and manufacturing industries, but also the production of new varieties of consumer goods. The potential market for practically every enterprise was suddenly multiplied many times, and those enterprises which were most far sighted, bold and energetic, increased their business in proportion to the opportunities offered by the larger markets.

Increase in volume of sales called for increase in production capacity, which stimulated corporate organization, plant extension and the introduction of labor-saving equipment made possible by the new engineering. Out of this emerged a combination of new managerial problems; beginning of the separation of ownership and management and of a responsibility of management to investors not concerned with details of managing; intenser competition and narrowing of the margin of profits; difficulties of coordinating and supervising more specialized machine operations; larger investments of capital in fixed form and danger of obsolescence resulting from poor judgments of the development of the markets; the danger of older plants becoming marginal plants, and of marginal plants becoming profitless plants as the opening of new territories shifted the center of gravity of markets for materials and consumer markets in favor of newer plants. Industry became perplexed and seriously thoughtful, and the thinking of individual enterprises focused about the basic problems of competition, stability, profits, the elimination of waste and business efficiency—conditions of individual survival in the midst of increasing prosperity of industrial society generally.

In contrast to the general attitude of opportunism set by the earlier frontier conditions appeared a new attitude—that of predetermination of success through understanding of the factors conditioning enterprise, and through planning and control of operations in terms of these factors. It was its logical and understandable expression of this new attitude which enabled scientific management to become the dominant force in the management movement. As part of this new general attitude were many component attitudes, each offering a contrast between the old and the new.

Some Basic Contrasts. 1. *Conservation versus Waste.* The idea of conservation did not at once take the social point of view that individually profitable methods in industry may be socially wasteful, and this idea has gained headway only slowly during the past fifty

years. But to many managements came recognition that there were wastes of facilities in their productive processes, and that one way to compensate for the narrowing margin of competitive profits was to eliminate these wastes. Elimination of waste has been the most popular phrase to describe the meaning of the management movement.[1] This idea of elimination of waste at the machine or work place has since been extended to include elimination of waste in all the activities of an enterprise, and has had influence in developing the still larger concept of social waste.

2. *Investigation versus Imitation.* A natural habit which makes for progress is that of observations of what others do and imitation of the more successful; and improvement by imitation, slow as it is in achievement of results, accounts in the long run for much of the improvement in management. As a part of the new point of view this became changed from casual to purposeful imitation, and then to it was added something of a much higher order—investigation and experiment with respect to the causes of waste in the individual plant. Although Taylor did not hesitate to imitate, he attached to it careful valuation and adaptation. But he did more than imitate; research and experiment as applied to the *use* of facilities constituted his greatest contribution to the development of a science of management.

3. *Predetermination versus "The Way Open."* Under frontier conditions the dice of industry were loaded by generous nature, and most of the throws resulted in gain for the player. This had developed a dominant attitude of taking things as they came; that sufficient unto each day are the opportunities and the problems thereof. There was not much difference in this respect between the itinerant peddler of the byways and the manufacturer in the city. But experience with research, experiment and measurement stimulated new ideas, among them that the performance of a machine and its operator can be predetermined. And from this has grown the still larger idea that all the operations of an enterprise may in varying degrees be predetermined. Whereas the new technique began fifty years ago with the measurement and scheduling of machine operations only, today we have the budget as a device for the measurement and scheduling of the total operations of a business.

4. *Design versus Execution.* Predetermination compels the recognition of design as a function distinct from execution, and requiring different capacities. This does not signify a less respect for the importance of execution and of executive ability; it signifies the

[1] Cf. for illustration, the title of the committee appointed by the Federated American Engineering Societies in 1921. "The Committee on the Elimination of Waste in Industry."

recognition of another equally important supplementary function and capacity. That the direction of the operations of a plant is analogous to direction of the operations "of a complicated and delicately adjusted machine" was early a favorite concept of the management movement. It has not been a long step to the correlative idea that management may be designed in every part; that it may even be laid out on blue prints by use of accumulated, classified experience, and if so laid out is more likely to meet the requirements of predetermined and defined purpose.

5. *Constants versus Variables.* But predetermination and design of management cannot be achieved if the factors involved are always changing. Calculations must be in terms of constants in designing management as well as in designing a building. There must be dependability in the reaction of forces in the application of human as well as of mechanical energies. Knowledge of the reactions of mechanical energies has progressed remarkably through research in the physical sciences. Accumulation of knowledge concerning reactions in the application of human energies is under way. Its acquisition is stimulated by belief that constants in human reactions can be made available by selection of individuals according to capacity and by provision for common understandings. The search is under way for constants even in mass human reactions through the device of statistical measurement. And in this connection it should be observed that mass reactions which on the surface indicate great variability may, when analyzed and measured, disclose elements of constancy available for calculation; as when in a time series there is discovered a definite rate of change, or in other groupings definite norms and dispersions about these norms.

6. *Laws of the Situation versus Individual Guess and Arbitrary Will.* It was the practical assumption of earlier American industry that an individual who has done anything well can do everything well; that the individual is the determining factor in management. But the new interest in predetermination and control led to increasing recognition that the non-human portion of a managerial situation embraces a larger number of inflexible, unyielding factors than does the human portion; that humans may by selection and training be adapted to the situation more easily than the situation can by change be adapted to humans. More recently this view has been refined by recognition of the interplay between the individual and his environment, in which each molds the other; but the greater inflexibility of the non-human factors is acknowledged. Carnegie once observed that his business might be destroyed but, if his organization remained intact, he could speedily restore it. By this he meant that speedy and thorough restoration of the business would be easy if he could have available the group adjusted in understanding and skill to the requirements of the

business. Taylor said that an organization composed of individuals of mediocre ability, working in accordance with policies, plans and procedures discovered by analysis of the fundamental facts of their situation, would in the long run prove more successful and stable than an organization of geniuses each led by inspiration. Generally the permanently progressive enterprise is an organization of cooperative individuals commanding accurate knowledge of the basic facts pertaining to their respective responsibilities. It may be led by one outstanding individual, but his leadership is permanently constructive only if exercised with understanding and in a close working relation to the durable facts of the situation.

Taylor was more responsible than any other industrial leader for the introduction of this point of view into management philosophy. The development of his system began with research and experiment; the first of his principles is a science for each operation; and in his writings and public addresses he repeatedly referred to the rule of law.[1] He said he believed that the "bulk of mankind wants to work under and wants to live under laws," and that "the old arbitrary way of having a dictator, who was at the head of a company, decide everything with his dictum, and having his word final, has ceased to exist."[2] Miss Mary Follett has observed that the essence of scientific management is substitution of the laws of the situation for arbitrary authority.[3]

7. *Functions versus Persons.* Recognition of the relative fixity of the non-human elements in a managerial situation, and search for the laws which they impose, leads to recognition of the importance of knowledge of the functions in each situation. By "functions," as the

[1] "Management is a true science, resting upon clearly defined laws, rules, principles, as a foundation." *The Principles of Scientific Management,* p. 7. "One of the important objects of this paper is to convince its readers that every single act of every workman can be reduced to a science." *Ibid.,* p. 64. "The laws of cutting metals should clearly show the reason why it is impossible for any machinist . . . correctly to guess . . . (the feed and speed to use)." *Ibid.,* p. 112. "There is another type of scientific investigation . . . which should receive special attention, the accurate study of the motives which influence men . . . laws of this kind, which apply to a large majority of men, unquestionably exist. . . ." *Ibid.,* p. 119. "Standards which are accepted as the just and fair laws . . . the president of one of these companies would no more think of interfering with than the workman would." Testimony, reprinted in the *Bulletin of the Taylor Society,* Vol. XI, No. 3, June-August, 1926, p. 146. ". . . develop laws to replace rule-of-thumb." *Ibid.,* p. 128. "The old-fashioned dictator does not exist under scientific management. The man at the head of the business under scientific management is governed by rules and laws which have been developed through hundreds of experiments just as much as the workman is." *Ibid.,* p. 161.

[2] Testimony reprinted in *Bulletin of the Taylor Society,* Vol. XI, No. 3, June-August, 1926, pp. 161 and 169.

[3] Metcalf, Henry C., Editor, *Scientific Foundations of Business Administration,* Baltimore, The Williams & Wilkins Company, 1926, p. 140.

word is used in management literature, is meant the logically separable elements of an integral whole of activity which have each a distinguishing characteristic, such as the effect of the activity or the nature of the skill required; for instance, the function of design and the function of execution. The search for laws must be search in restricted areas, one after another, for laws are more likely to be discovered in an area having a unifying characteristic and complementary to another area with its unifying characteristic. The procedure of analysis of the total activities of an enterprise in terms of necessary component functional activities has been an important factor in discovery of the most suitable organization for an enterprise, and in the selection and assignment of persons for performance of the functions involved. The older procedure in organization, for instance, of the administrative and executive section of an enterprise, was to secure the men first and then consider their positions and authorities; the newer procedure is to determine the functional requirements of the enterprise and then secure the proper human capacities for assignment to the several responsibilities.

8. *Adjustment versus Maladjustment.* Resulting from recognition of the fixity of non-human factors in managerial situations, the search for laws which govern cooperative activity, and the recognition of the importance of analysis of functions, was consideration of human adjustments in accordance with capacities. Certainly one outstanding achievement of modern psychology is proof and measurement of variability in characteristics among individuals; of a norm and dispersion about the norm with respect to any characteristic. But before this new psychology had appeared, the management movement had begun in practice to disregard the traditional assumptions that all men are created equal in ability, that any man can do anything, and to seek men adapted by nature, training and experience for particular functions.

Taylor was a pioneer when he incorporated this point of view into his technique and his philosophy. The first man he selected for his experimental research at Midvale was a skilled (adjusted) man, and thereafter much of his attention was given to discovery and definition of capacities for particular operations. In his experiments in handling pig iron and in shoveling, discovery of the most suitable type of man was an essential part of discovery of the best methods,[1] as was also the case in developing scientific management in the inspection of balls for bearings—"Mr. Thompson soon recognized that the quality most needed for bicycle ball inspectors was a 'low personal coefficient.' Of course, ordinary qualities of endurance and industry were also

[1] Taylor, Frederick W., *The Principles of Scientific Management,* New York, Harper & Brothers, 1911, pp. 59 ff. and 65 ff.

called for." [1] His differential piece-rate system had as the objective the automatic selection and reclassification of workers in accordance with natural and acquired capacities; and in his testimony before the Committee of the House of Representatives he discoursed at length on the grouping of men into capacity classes, illustrated by the classification of horses into draft, driving, and racing horses.[2] "What I want to make clear is that each type of man is first class at some type of work, and if you will hunt for it enough you will find some kind of work that is especially suited to him." [3] Again: "Under scientific management we make a definite and careful study of each workman in the place; men are appointed in all these establishments whose chief duty is to make this study of the workmen, of their possibilities and their character, and then to deliberately train each of these workmen to do that work for which he is best fitted." [4]

9. *Cooperation versus Individualism.* It was an essential part of the new outlook toward management that effective joint effort of complementary specialists working for the accomplishment of a common purpose must be *truly* cooperative; must be effort in which there are in general common desires and motives, and understanding and acceptance of the nature and effects of specific acts. Predetermination and effective execution of planned action cannot be established if these are not present. In the testimony before the Committee of the House of Representatives this point of view was repeatedly emphasized by Taylor. "Scientific management exists nowhere . . . until this new idea of cooperation and peace has been substituted for the old idea of discord and war." [5] "Nine-tenths of the improvements that have come under scientific management have come from this friendly cooperation on the part of the workmen with the management. Almost all the best suggestions for improvements come from intelligent workmen who are cooperating in the kindliest way with the management to accomplish the joint result. . . ." [6] "The workmen have the same sort of freedom, and they have just the same opportunity, to enter into every experiment which is made in establishing what constitutes a fair day's work that the management have. The making of joint experiments (the workmen and management cooperating together) has been universal in scientific management, or practically universal, and the results have been satisfactory to both sides. I wish to emphasize the

[1] Taylor, Frederick W., *The Principles of Scientific Management,* New York, Harper & Brothers, 1911, p. 89.
[2] *Bulletin of the Taylor Society,* Vol. XI, No. 3, June-August, 1926, p. 155 ff.
[3] *Ibid.*
[4] *Ibid.,* p. 143.
[5] *Ibid.,* p. 104.
[6] *Ibid.,* p. 146.

fact that until results of these experiments are satisfactory to both sides, scientific management does not exist." [1]

10. *Freedom versus Independence.* Cooperative effort in obedience to the laws of the situation destroys the imaginary absolute individual independence accepted as desirable by the older point of view, but it creates a compensating individual freedom not realized under conditions of apparent absolute independence. The price of effective cooperation is adjustment and the price of adjustment is apparent diminution of independence. But independence without the law is more restrictive in fact than adjustment under the law. Independence in cooperation without the law is an illusion, for the individual is subject to the arbitrary will of the persuasive, strong or tricky cooperator. Said Taylor, "Under scientific management those men who are in the management, such as, for instance, the superintendent, the foremen, the president of the company, have far, far less arbitrary power than is now possessed by the corresponding men who are occupying those positions in the older types of management." [2] De Freminville, the distinguished French engineer, has observed: "They have laughed at the Frenchman who, whether as workman or soldier, has been willing to obey, but does not wish to be commanded . . . it is no laughing matter. . . . He is in fact the same man who says when he comes into a shop where order reigns, 'here, at least, one feels one's self under command.' He feels it for himself without anyone's being obliged to call it to his attention, which makes the whole situation quite a different matter." [3]

11. *Evolution versus Revolution.* The new point of view accepted as a practical necessity the doctrine that progress must be the result of orderly and gradual rather than arbitrary and sudden change. Under the older conditions of opportunism and imitation, managements were accustomed to change objectives and conditions of work arbitrarily and suddenly. But with research as the procedure for determining objectives and methods, and with standard procedures as the accepted methods of cooperation, change by necessity must be deliberate, must in fact be a product of scientific discovery and of education. It is a matter of change of mental and physical patterns of habit and is subject to the laws of learning. The "efficiency movement," a counterfeit of scientific management which has wrought no little harm to many a business, represents an effort of the opportunistic, imitative, get-rich-quick spirit to utilize the mechanisms of scientific management for immediate gain. It is more difficult for management to learn

[1] *Ibid.*, p. 158.
[2] *Ibid.*, p. 169.
[3] *Bulletin of the Taylor Society,* Vol. X, No. 1, February, 1925, p. 36.

to pay the price of relinquishing arbitrary authority than for workers to learn to desire and acquire the skill of experimentally determined methods. Taylor did not soften his phrases when discussing these matters. "You cannot persuade any set of men, employers or employees, to adopt the principles of scientific management immediately. I have always said that it takes a period of from two to five years . . . I wish to repeat and emphasize that nine-tenths of the trouble comes from those on the management side . . ." [1] "Do not expect to get through with it for five years, because you will not." [2] And with respect to a case of failure in an attempt to install efficiency instead of developing scientific management, he observed: "He attempted to do what is an utter absurdity . . . they abandoned the very essence of scientific management, the one essential thing. They tried to force in a whole lot of mechanisms which ought to belong to scientific management . . . They went ahead neglecting the absolute necessity of the mental change . . . I told them 'If you do not go slow enough; if you do not allow the workmen to see that it is a fine thing for them . . . so that they will cooperate with you thoroughly, the time will come when the whole thing will fall.' . . . it was the owners who finally made the thing go wrong." [3]

It should not be inferred that the opportunistic attitude of mind has disappeared from American industry. It survives in many industries, and where it exists it is conspicuous. The proper inference to be made is that the new point of view has won an equally conspicuous position. A struggle between the two is under way. The old still holds its own in enterprises where appropriation, speculation and monopoly appear to be possible; the new is becoming dominant in enterprises which realize that survival depends upon competitive service and economical processing. The coal industry, for example, is militantly representative of the old; the machine manufacturing industry is the stronghold of the new. In the textile industry the majority of plants by habit represent the old—in a dazed rather than militant way; but the active successful plants represent the new. The automobile industry is progressing from the old to the new, some plants representing one, some the other, and some both—in which case in a given plant the new may be dominant in processing and the old in merchandising and general administration, as is the case in many other industries. The coexistence of these radically different attitudes of

[1] Testimony reprinted in *Bulletin of the Taylor Society,* Vol. XI, No. 3, June-August, 1926, p. 138.

[2] *Ibid.,* p. 178.

[3] *Ibid.,* pp. 183 and 184.

mind is accounted for by the fact that the United States is a vast area with various combinations of physical and social factors, various practical conditions of business success, and presents every degree of industrial evolution.

Scientific management when it introduced the new point of view was indeed twenty years ahead of its time, if judged by the capacity for its reception on the part of the majority of managers at the time. Yet there were sufficient managers to make the beginnings of a response and the response has grown with increasing acceleration. It is true that there have not been many developments representing the complete transformation of an enterprise,[1] for that requires masterful leadership,[2] but it has come to be the dominant force in American industry through the transformation of one or more departments of practically all strong enterprises—here in production, here in selling, there in general administration, and elsewhere in several departments. The following chapters constitute a fair picture of the spirit and sweep of scientific management today.

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[1] For a brief description of a deliberate, patient and effective all-round development cf. *Bulletin of the Taylor Society,* Vol. XII, No. 6, December, 1927, p. 519.

[2] Cf. Chapters XXVII and XXVIII.

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CHAPTER III

THE INFLUENCE OF SCIENTIFIC MANAGEMENT [1]

President Herbert Hoover's Committee on Recent Economic Changes has reported after studying for more than a year the course of post-war developments in American economic life.[2] The Committee was charged by the President's Conference on Unemployment, of which it is a part, with the task of making a critical appraisal of the new factors in our economy and of the shifts in the importance of the older factors.

The Committee finds that acceleration rather than structural change is the key to an understanding of recent developments. Few really new factors have emerged in the post-war period. On the other hand there have been differences of degree which approach differences in kind, and the advance of scientific management is one of them.

The technique of economic balance on which the report lays most stress can be perfected only by incessant observation and adjustment. The Committee [3] suggests that "research and study, the orderly classification of knowledge, joined to increasing skill, well may make complete control of the economic system a possibility. The problems are many and difficult, but the degree of progress in recent years inspires us with high hopes." This is, to me, the heart of the report. It directs our eyes to the central position of scientific management in the national economy and it suggests that future advances will be more purposeful and self-conscious.

The report is based upon the results of a far-reaching national reconnaissance, made by a corps of experts under the direction of the Na-

[1] By Edward Eyre Hunt, member, Committee on Elimination of Waste in Industry; Secretary, President's Conference on Unemployment; Secretary, United States Coal Commission; American expert on scientific management at World Economic Conference, Geneva; editor, *Recent Economic Changes,* Washington.

[2] *Recent Economic Changes in the United States,* 2 vols., New York and London, McGraw-Hill Book Company, Inc., 1929.

[3] The Committee consists of Herbert Hoover, Chairman; Walter F. Brown, Renick W. Dunlap, William Green, Julius Klein, John Lawrence, Max Mason, Adolph C. Miller, Lewis E. Pierson, John J. Raskob, A. W. Shaw, Louis J. Taber, Daniel Willard, George McFadden, Clarence M. Woolley, Owen D. Young and Edward Eyre Hunt, Secretary.

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tional Bureau of Economic Research, Inc., with the aid of governmental and private agencies.

In a chapter reviewing the fact-finding reports prepared for the Hoover Committee, Dr. Wesley C. Mitchell condenses the findings into a single striking sentence: "Since 1921, Americans have applied intelligence to the day's work more effectively than ever before."

It is useful to see ourselves through alien eyes. The diagnosis of foreign observers who have flocked to the United States in recent years, confirms and strengthens the impression of the American experts. Dr. Edwin F. Gay of Harvard, who summarizes the impressions of our visitors, after noting the emphasis placed by foreign observers upon our natural resources, high wages, labor-saving machinery, power and our great domestic market, adds: "Scientific management in industry and commerce, apparently the resultant of emerging pressures, is thought by many of the foreign writers on recent economic changes in the United States to be the chief contribution which this country is making to economic welfare and to be the key to its success. . . . Such far-sighted management is becoming highly specialized; a new profession is entering into the structure of American industry and it is separating the functions of ownership and management."

Foreign observers also note that "American management has begun more systematically to improve industrial relations"; that the new labor union policy "recognizes not the identity but the mutuality of interest between the two parties to the labor contract"; and finally, as a related factor in American economic efficiency, "the open-mindedness of American management."

The experts of the National Bureau, studying manufacturing, transportation, marketing, management, labor, agriculture and banking reach the same general conclusion in an effort to explain the recent developments; namely, that management has made notable strides during the period under review.

Dexter S. Kimball, Dean of Engineering at Cornell, even states that "the problem of industrial production has been solved and as a consequence we have passed from a 'sellers' market' to a 'buyers' market.'" He shows that the World War, unlike the Civil War, developed no new basic productive processes. The post-war advance has been chiefly in management.

L. P. Alford, vice president of the American Engineering Council and a member of the Hoover Committee on Waste in Industry in 1920-1921, reports on technical changes in manufacturing industries, finding as characteristic of the period studied, an increase in physical volume of

product, an increase in productivity of the worker, an increase in primary power utilized, a decrease in the number of workers employed, an increase in fixed capital assets, a decrease in unit prime cost, an increase in industrial research, increase in the development of new manufacturing materials, increase in the development of new manufacturing processes, increase in the efficiency of power-generating machinery, increase in material handling machinery utilized, reduction in wastage, increase in safety, increase in the extent, degree and quality of artificial illumination, improvement in working surroundings and in those physical conditions that can be modified by technological means.

In discussing the evolution of management in manufacturing and marketing, Henry S. Dennison, former president of the Taylor Society, presents the results of an analysis of a hundred fair samples of normally successful, established businesses, so chosen as to show prevailing practices. And he concludes that "the situation of today holds all the opportunity anyone could desire for the wholesome development of business management into a great profession."

I can do no better than to quote from Mr. Dennison's summary.

"The art of management, in almost all its aspects and activities, turned a corner in 1921. During the up-swing with which the century started, sheer power and drive could win almost every time over finesse. At the turn of the tide, amid the confused cross-currents, more depended upon skillful understandings of the whole situation and nice adjustment of means to the immediate environment. The art of management today is in large part the progressive adjustment and integration of conflicting needs, conflicting influences and conflicting purposes.

"All managers, however, did not turn the corner in 1921. A reorganization of thought has had first to be brought about. Under the new charter, to manage is not a vested right but the exercise of a special skill which, through temperament or through training, some have and some have not. An English article expresses it strongly: 'Nothing is more characteristic of modern business than the way in which control based on power and ownership is giving place to authority based on knowledge, qualifications and skill. Management is no longer a preserve of the owners of capital, nor is it an hereditary right. Men of ability, without capital or family ties to assist them, are breaking into the hereditary ranks. Industrial conditions are in their favor. . . .

" 'The leveling forces of Nature have been at work, producing the average except in cases where systematic selection has been exercised. But the average man is not equal to the strain of a day when condi-

tions are uncertain, when business is growing more complex, and when nothing but competent administration can enable a firm to survive.'

"To cope with the growing complexities, the manager type, through slow processes akin to natural selection, is changing. More men are being brought within managerial responsibilities, and the coordinated group, each member of which has his own share in the total of responsibilities, is replacing the absolute 'big boss.' To release and utilize all the creative and managerial abilities which any of their members may possess or develop is the definite goal of organization. There is today not only more production per man, more wages per man, and more horse-power per man, but more management per man as well."

Professor William J. Cunningham of Harvard, writing on transportation, quotes a statement of President Hoover while Secretary of Commerce, that the reorganization of American railways and the improvement in rail-transportation service is probably the most outstanding industrial accomplishment since the war.

Students of scientific management who remember the Eastern Rate Case in 1911 and the sensational testimony then given, will be impressed with the great changes which have since taken place. In nearly every index of equipment utilization, train and terminal operation, and output per man-hour, notable improvements have been made. These are attributable in part to the large expenditures for additions and betterments, in part to changes in operating methods and better managerial control, in part to higher employee morale and in part to a better understanding and more cordial cooperation on the part of the shipping public. Mr. Hoover is further quoted as stating that the railways "not only have built up adequate service . . . , but they have, by great ability of their managers, greatly reduced transportation costs and thus made rate reductions possible which would not have been otherwise the case. . . . The result of this great reorganization upon the whole economic fabric of the country has been far-reaching."

Dr. E. G. Nourse, writing of agriculture, shows the tremendous strides of scientific farm management in recent years. He believes that the best farmers are not leaving agriculture, and shows that what is actually happening is "the slow adjustment of our farming to drastically changed conditions, a process in which the efficiency of agriculture bids fair to be sharply advanced and the prosperity of those who can measure up to the larger needs of this new technique should be proportionately raised. The better farmers, who have adopted the modern methods, are in a large number of cases already enjoying this prosperity."

The evidence of the experts and the judgment of the Committee relative to high wages is particularly noteworthy. Twenty-six years ago Frederick W. Taylor wrote in the introduction to *Shop Management*: "This book is written mainly with the object of advocating high wages and low labor cost as the foundation of the best management." Not until 1922 was there even the beginnings of general assent to this principle, the factors appearing to be in part accidental and in part the consequences of an advanced economic point of view.

The Hoover Committee is greatly impressed with this economic and social fact. In the field of price relationships, high wages and a stationary cost of living it finds one of the striking and significant developments revealed by the survey, and one which more than any other gives to the years from 1922 to 1929 their distinctive character. The Committee rightly points out that the principle of high wages and low costs as a policy of enlightened industrial practice is in no sense new, but that its application on a broad scale is so novel as to make it appear to be a fundamental development.

Dr. Person, in Chapter I of the present volume, lists management research, management standards, management control and cooperation as the four principles of scientific management today. All of these must contribute to further the economic balance which the Committee on Recent Economic Changes presents to us as the aim of public and private policy.

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PART II

MANAGEMENT RESEARCH

In a world of continuous emergence and dissolution, the ambition to frame the last word never indicates anything but narrowness. As long as mankind lives the absolutely last word will never be uttered; for ever and ever, the problem of mankind will present itself anew, and life will forever remain a thing of problems.—Count Hermann Keyserling.

Scientific management at every step has been an evolution, not a theory. In all cases the practice has preceded the theory, not succeeded it. In every case one measure after another has been tried out until the proper remedy has been found. Every new element has had to fight its way against the elements that preceded it, and prove itself better. All the men that I know of who are connected with scientific management are ready to abandon any scheme, any theory, in favor of anything else that can be found that is better. There is nothing in scientific management that is fixed.—Frederick W. Taylor.

CHAPTER IV

RESEARCH FOR GENERAL ADMINISTRATION [1]

IF MANAGEMENT is to be in any sense scientific, it is essential that administrative decisions be based on investigation and analysis of facts rather than on the arbitrary and hasty edicts of officials. The type of investigation which deserves first attention from the logical point of view is concerned with those problems of general administration which are the province of the president and the board of directors. It must be admitted that these problems, while logically first, have been almost the last to receive systematic attention, and even now have received less careful treatment than the more limited but concrete problems of the shop. In fact, many even among business men do not distinguish clearly what general administration is, or realize the importance of careful analysis of its problems.

The Nature of General Administration. By general administration is meant the determination of the general policies of the business, the adaptation of general plans to changing conditions, the coordinating control of the various major functions of the business and the appraisal of results secured by departments. The existence of such a thing as general administration may not be recognized by the chief executive of a small concern, whose mind is occupied by particular problems of buying, selling, designing, making, employment or pay adjustment. But in any business which grows past the point where one man can personally make all decisions, it is necessary, first, to cease deciding every issue as a separate special case and to establish normal policies and procedures; and second, to separate the problems of general concern from those pertaining to only one function of the business.

Let us consider briefly what are the distinguishing features of general administration as contrasted with the administration of the various major functions controlled by it.

The merchandising and sales functions, as distinguished in subsequent chapters, are concerned with most of the specific problems of distribution, such as market analysis, analysis of the value and uses of goods, the computation of sales-production schedules, the computation of detailed prices, the determination of quotas, the training and

[1] By Robert W. Burgess, Chief Statistician, Western Electric Company, New York.

direction of the sales force, detailed records of orders, sales and stocks, and advertising. But the function of final decision with respect to such things as the desirable volume of sales, quantity of advertising and pricing policy—matters requiring a balanced point of view because involving general policy and a balancing of departments—is a general administrative function.

Likewise purchasing is a special function concerned with such activities as selection of sources of supply, analysis of price tendencies and the placing of orders. But such problems as determining whether purchases shall be on a "hand-to-mouth" basis, or whether forward buying may be advisable, are general administrative problems.

The administration of receipts and expenditures, the keeping of general accounts and the analysis of the results of expenditures, are particular responsibilities of the treasurer and the comptroller; but such problems as whether a new bond or stock issue shall be made to finance an expansion, what method of depreciation shall be utilized in accounting, and how additional capital shall be invested, are problems of general administration.

The engineering department is concerned with invention and design, but the adoption of an invention or design is an administrative problem. The personnel department is responsible for such things as employment and training of workers, safety and health, and the administration of benefit, stock purchase and similar plans; but determination of wage policy or the institution of a stock purchase plan are responsibilities of general administration. With respect to the production processes there is least likelihood of confusing responsibilities. The departmental staff is concerned with the immediate processing, and with what, how much, when and how in detail; but general administration is concerned with such things as what, how much, when and how in the large, as concerned with general policies, and with investments in new facilities.

The key topics around which general administration revolves are earnings and dividends, wage policy, determination of general line of product or service to be supplied, approval of technical research programs, the budget, turnover of investment, comparison of operating results with those of preceding years, and with the budget, prices, depreciation, taxation and plant location.

Division of Managerial Labor. It must be admitted that some, even among successful executives, do not distinguish general administration from other functions as we have done. Another point of view is that the duty of the president of a company is to devote himself to those duties which seem to him at the moment to demand special attention, either because of their importance or because of the unsatis-

factory nature of the work being done by the officer immediately in charge. According to this point of view, the president ought to be more capable than the other principal officers in every one of their duties. Experience shows, however, that this demands an almost impossible collection of abilities in one man in the case of large concerns. It seems more in accordance with the general principle of division of labor on which modern industrial organization is based to regard general management as a separate craft, with sales management, management of design engineering, factory operation and so on, as other crafts. All of these managerial crafts are to be distinguished in turn from the skilled trades and the business professions, such as engineering and accounting. It is, of course, true that a natural way to become a qualified practitioner of the crafts of general management is to begin in a skilled trade or work of a professional type, to progress to the type of management associated with that trade or profession, and finally to enter upon general management. While such a method of approach to a general managerial position is natural, it is most important to recognize that the steps are marked by definite changes in type of work.

If this point of view is accepted, the following corollaries appear to follow:

1. The fact that a man is highly skilled in a certain trade or business profession does not necessarily imply that he will be a good man to administer a department whose workers are mainly of that type. In any case, he should realize that it is a different job which requires a different attitude of mind and probably additional training.

2. The fact that a man is a good department manager does not necessarily imply that he will be a good general manager, unless he adopts a broader point of view.

3. A high-grade specialist, in the engineering laboratory for instance, may deserve a larger salary than the supervisor to whom he nominally reports, if the specialist is a more valuable expert in his craft than the supervisor is in the work of management.

4. A functional manager, such as a sales manager, who is unusually successful, may be entitled to greater compensation than the president of his company. Admittedly this is true only in unusual circumstances, as men who are really capable in the field of general management have a high scarcity value.

5. If a president believes that the work of a particular department is not being done satisfactorily, the best remedy is not to do the most important part of that work himself, but (1) to try to correct the department manager's faults, (2) to rearrange the assignment of duties among different departments so as to meet the difficulty or (3)

to replace the department head by somebody presumably more competent in administration and management.

Research for General Administration. Even if we regard general administration as a separate craft, in which a man may become qualified without being omniscient, the task of the general administrator is nevertheless most exacting and calls for the use of the best aids that experience has developed. One of the most important aids is research, carried on by himself or others, devoted specifically to these problems. By "research for general administration" we mean:

1. Any attempt to discover, by analysis of operating returns, comparison with related information, or by additional investigations, what are the results of any existing general policy or what the effects of any proposed change in policy or plan of operation would be.

2. Development of methods for appraisal of results secured by different departments or for general control.

The underlying motive back of such research is to secure a broader perspective than is present without it, by comparing the present with the past or the estimated future, by comparing the particular company with other concerns, or the particular industry with other comparable industries.

The sphere of research does not include those modifications of plans which are often made by industrial concerns for personal reasons. It seems clear that in certain cases it is desirable to take account of the capacity of the individuals concerned or even of their likes and dislikes in deciding what is the best thing to do. From the point of view of the executive interested in general administration, however, any recognition of the personal factor is fraught with the danger that it may be somewhat of a departure from strictly scientific management. Certainly no president of a company can justify a plan which is based on his own dislike of some other man. On the other hand, a plan must have the support of individuals if it is to succeed, no matter how scientifically it may have been made. It is the province of the practical administrator, as distinct from the research worker in general administration, to temper the details of a scientifically drawn plan so that it will be understood and used whole-heartedly by the entire personnel of the company.

Kinds of Research and Typical Problems of Each Kind. 1. *Business Conditions and Tendencies.* The meaning of research for general administration will be brought out by discussion of some of the lines of research which have been undertaken by progressive concerns and of various typical problems of each kind. One of the first and still one of the most prominent kinds of research is analysis of the current rate of business and industrial activity. The purpose of such

research is to guide executives as to the correct timing, with respect to industrial conditions, of projects such as purchases, plant expansions, advertising campaigns and variation in the size of the working force. The general method is to survey at regular intervals the various barometers of such items as production, prices, employment, earnings of industrial concerns and outstanding business or political events. The aim is, in brief, to determine what is the present position in the business cycle and to estimate, if possible, the course of events in the near future. The development of this idea requires the use of certain statistical techniques, especially determining index numbers, trends and seasonal factors, as any forecasting is significant only if based on a careful analysis of past relationships. As it is impossible to go into details as to this type of analysis in the space available, the reader is referred to references three and six at the end of this chapter, in which these methods are explained and illustrated.

It may be noted that the United States is especially fortunate in possessing a large volume of current business statistics, prepared by governmental and other sources, and made available promptly month by month.

2. *Analysis of Industrial Developments.* Another kind of research which is related to the preceding, but may well be distinguished therefrom, is an analysis of industrial developments with a view to determining the significance for the researcher's own company of changes in the economic environment. This type of research is carried on by (1) extensive study of current business and economic literature; (2) personal contacts with government officials, business executives, analysts, etc.; (3) continuing study of trends of important series; (4) intensive study of problems that seem to have significance for the particular concern.

As problems typical of this kind of research, the following are offered:

a. Under what conditions has vertical combination of industry been successful? Has it been more likely to succeed when two different companies have been united, one of these companies being the consumer of the other's products, or when a large company has added a new department to take care of a stage in production either before or after that previously handled?

b. What is the significance of the decrease in factory employment accompanied by an increase in output? To what extent is this increase explained by increased efficiency of the individual worker, by more careful selection of workers or by greater use of machinery? What are the results on supply of factory labor, consumer demand due to

reduction of number of workers receiving pay envelopes, and increased need for measures to relieve the unemployed?

3. *Analysis of Internal Conditions.* The two preceding kinds of research have to do primarily with the world outside the particular company. Another appropriate field for the activity of a unit or department devoted to research for general administration is the analysis of internal conditions affecting more than one department or function. The purpose of such analysis is to investigate and report on the internal operations of the company so as to facilitate wise decisions as to major questions of policy. A helpful element in these investigations is comparison with figures for outside concerns.

Among the typical problems of this kind the following may be mentioned:

a. Will it be more desirable for the company to continue to purchase items of a certain class or to manufacture them? It is obvious that light may be thrown on this question by the investigation of vertical integration of industry.

b. What have been the price trends of what we buy and what we sell, in such form as to permit fair comparison with general price trends?

c. Are the changes in price of our product accounted for by changes in costs of our raw materials and labor, and by increased efficiency?

d. What obligations has the company already incurred under its pension plan, and what will be the annual increase in such obligations? What method of providing for these obligations is desirable? This problem is related both to the accounting function and the personnel management function.

e. What is the typical rate of increase of employee earnings with increasing service? Is this condition satisfactory, in view both of what other companies do for their employees and the necessity for maintaining production costs at as low a level as possible?

4. *Standard Control Ratios.* The types of research mentioned above are concerned with the formation of general plans and affect the board of directors especially. Another type of research fits in more closely with the job of the president. In order to control the progress of the company, to see that policies are being carried out and to call attention to places in the organization which require special executive action, it is desirable to follow currently certain key ratios. Before such ratios can be used to advantage, research is necessary to develop the true significance of particular values of these ratios. For instance, one of the important ratios used in railroad administration is average number of miles per day for each freight car. By comparing the current result with an average for earlier periods or for similar

roads under similar conditions, the executive is able to detect unusual conditions. It is not safe, however, for this comparison with previous experience to be made on a superficial basis, or to accept without investigation the opinions of "old timers," which are probably not sufficiently modified to reflect changed conditions. It is sometimes advisable to check a suggested scheme by using it informally for a while before making it a basis for executive action.

Railroad administration is full of ratios which are used for control purposes, such as revenue per ton mile, cost per ton mile, ton miles per engine mile and percentage of bad order equipment. Other questions which call for determination of ratios are as follows:

a. What return on investment is reasonable and fair for a manufacturing subsidiary of a public utility?

b. What ratio of current assets to current liabilities is advisable for a concern such as John Doe and Company?

5. *Appraising the Work of Departments.* Another kind of research of a more difficult and controversial nature is the development of methods for appraising the work of major departments. In most organizations at present the judgment of the chief executive as to the effectiveness of a department depends largely on personal impressions and a rather vague evaluation of its performance. The records tell, especially if control ratios have been developed, more or less about what the department has actually done, but give a less definite analysis of the obstacles which were overcome and the resources available to overcome them.

In spite of the indefiniteness of the information available, the chief executive is continually required to decide how satisfactorily each department is doing its work and which department heads should be transferred to other spheres of usefulness. It is therefore desirable to work out methods by which he can form a more scientific judgment and such methods are in the process of development in a few special industries. They are not yet developed, however, as a general procedure. One of the major difficulties is a natural result of the fundamental nature of the problem. A good method for evaluating the success of a particular department may show that it is much overmanned, or that the head of the department is grossly incompetent. Human nature being what it is, it can hardly be expected that department heads will be enthusiastic about helping to devise searching tests of their own efficiency.

One obstacle which has hindered an adequate development of methods for testing departmental efficiency is the notion that a supervisor of any grade should know as far as possible all the details of the work done by his subordinates and can measure their performance

only by being able to do a better job himself. As long as this omniscience is the ideal, it is difficult to develop practical methods. The truer view seems to be that while detailed knowledge is helpful, higher executives can seldom know their subordinates' jobs as well as the latter do, and success in executive work depends on acquiring skill in watching results and "spot checking" details rather than in attempting to follow every step.

It seems clear that the most successful line of attack on the problem of developing general methods of appraising the work of departments lies in developing a large number of measures, each subject to limitations and requiring skillful interpretation. A most essential thing in working out such measures is an objective attitude and a clear realization of the exact function of each department in the organization.

Typical problems are as follows:

a. Has the advertising department spent more or less than was justified? (The answer to this question is especially difficult if the advertising is of the so-called "institutional" type, of which the object is to develop good-will rather than to sell specific items.)

b. Is the purchasing department doing a good job, allowing for the way that instructions have come to it from the sales and manufacturing departments, and for market fluctuations in price?

6. *Combination of Several Types.* It is clearly desirable to try to solve management problems in the form in which they come to the general manager. Even though the problem might be broken down into parts, each of which could be classified under one of the types discussed, the real desideratum is not the solution of these partial problems, but the coordinated answer to the original question in the form it actually occurs, so as to furnish the best available guidance to those responsible for executive decisions.

As the problems of this type are made up of a combination of problems of the types previously discussed, the methods to be used are a combination of all that have been mentioned—historical, mathematical, statistical and economic.

The following typify the problems which we would classify under this head:

a. What estimated rate of activity in this industry (especially for this company) should be used as a basis for budget and other forecasts? (Combination of Types 1, 2, and 3.) A valuable guide in dealing with this problem is the discovery, by the use of the statistical method of "correlation," of series whose fluctuations precede those of some series measuring the activity of this company or industry.

b. What policy should be adopted in regard to setting up depreciation reserves for plant and machinery? This problem really involves

both the second and the third kinds of research noted above, as the appreciation of the need for a systematic depreciation policy involves both an understanding of the way industries have faded away, either as a whole or in particular localities, and an analysis of the replacements which have been or are likely to be necessary in the particular plant because of wearing out, obsolescence or inadequacy. An understanding of economics will also answer the objection that depreciation is a question of accounting rather than general administration, by bringing out that the chances of ultimate success or failure, and the propriety of a particular rate of dividend, depend to a considerable extent on the depreciation policy adopted.

c. Will it be more profitable to do a small business at high prices, or a large business at low prices? (Combination of Types 2 and 3 and general economics.)

d. What shall be company policy as to replacing obsolescent machinery? (Combination of 2 and 3.)

e. Shall supplies ever be purchased ahead of actual needs in an attempt to take advantage of price fluctuations? (Combination of 1, 2 and 5.) (Decision rests on whether correct anticipation can be made of prices and company needs.)

f. Should salaries be advanced relative to wages to return to the 1914 relationship?

Selection and Organization of Research Workers in General Management. Three procedures are open to a company which believes that it would be profitable to do some research work in general administrative problems:

1. Members of the present force already occupied with line or staff functions may be asked to undertake this type of work in part of their time, being relieved of part of their present responsibilities to make this possible. This plan seldom results in much thoroughgoing research, even when the employees concerned have somehow acquired the research attitude. The difficulty is that the duties resulting from the more urgent established functions tend to absorb all the time and energies of such part-time researchers.

2. Consulting specialists in economics, statistics or business management may be called in to report on particular problems. The best instance of this procedure is the investigation conducted by Professor Seligman, of Columbia University, on instalment selling,[1] which was made at the request of the General Motors Corporation. The procedure is most likely to work successfully on problems which are of a general nature, and therefore familiar to an outsider, and least likely

[1] Seligman, Edwin R. A., *The Economics of Instalment Selling*, 2 Vols., New York, Harper & Brothers, 1927.

to be successful on problems which involve complicated interrelationships between various phases of the business of a particular concern. For the ordinary concern which is not in trouble, the outside consultant is not favored except for new and usual problems. A specialist who has been a part of the company long enough to understand thoroughly its established policies and peculiar problems, can usually suggest a method for handling a problem which fits in better with the established order. Of course, when the inside specialist has failed to solve the problem, and the difficulty continues and becomes serious, the outside specialist may be of great help.

3. A new unit may be established within the organization to carry on research in the various types of problems of general administration outlined in the previous section. This unit would probably also, especially in smaller concerns, do research work in problems of purchasing, selling, industrial relations or other functions as well as for general administration. If this is planned, care should be taken that all the energy of the new unit is not diverted from the general problems to the concrete and often attractive problems of these special fields.

The first essentials for workers selected for such a research unit is that they shall have minds of the analytic type and that they shall have the scientific attitude that problems should be solved by an impersonal determination of the facts and analysis of such facts by the best available methods. Usually this requirement implies special training in statistics, economics or business administration, or perhaps in physics, chemistry, mathematics, biology, engineering or other sciences. If the unit contains more than one worker (other than clerical), it is desirable that they have different types of training and experience. One man, for instance, may be an economist with special university training; another an engineer with experience in the company; a third an actuarial statistician, and a fourth a practical accountant familiar with the records kept by the different departments.

In dividing the work among several men, problems of the first and second type mentioned above—analysis of current rate of activity and analysis of industrial developments—might be made the special field of one man; problems of the fourth type might be assigned to a second man, and so forth. It is also usually advantageous to assign clerical helpers more or less permanently to the same jobs, so that as soon as the method of handling a recurring problem has been worked out, the maintenance of the records and routine analyses can be left largely in the hands of the clerks, thus releasing the trained specialists for assaults on new difficulties. Permanent assignment also makes it possible to train the clerical workers in specialized statistical techniques. Calculation of correlation coefficients, for instance, and of seasonal

factors, can be carried through almost entirely by clerks who are specially trained.

The attachment and name of the research unit for general administrative problems is a matter on which practice is not uniform. It may be called the Statistical Department or the Planning Department, and its head may report directly to the president, or perhaps more often to the comptroller, if that officer is responsible for coordinating the facts used as a basis for decisions by the board of directors. The essential points in this connection are that the field of activity of the unit shall be clearly understood, that it shall have authority to get the necessary internal facts that it needs, and that its findings shall reach with reasonable directness the officers who are really responsible for deciding policy.

Miscellaneous Principles and Suggestions. As in part a restatement of some of the points of this chapter, and in part a statement of related ideas which have not been mentioned, the following comments are made. It is still too early in the development of research for general management to lay down any set of formal general principles of management.

1. Every problem in management should be analyzed without passion, prejudice or desire for personal advantage.

2. As decisions on questions of general management require a difficult combination of detailed knowledge of a particular problem and a broad view of all aspects of the enterprise in relation to the industrial world, cooperation of specialists and general managers is essential.

3. Staff specialists assigned to assist the general management should combine as far as possible experience in the particular enterprise with a broad range of interests and the attitude of scientific research. Academic training in the physical sciences, mathematics or economics has often proved advantageous.

4. Information from all departments should be furnished regularly to some central department in so far as it is really desirable for deciding questions of policy, for appraisal of results secured by departments as a whole, or for central control. Reports comparing the units within a department, or helping to control the relative rate of activity of such units, should not be centralized.

5. The task of deciding on policies and seeing that they are carried out should be recognized as distinct from the task of investigating problems. Whether or not the same officers or employees do perform both functions is a matter on which the practice is not uniform. In general, little thoroughgoing research is likely to be done unless some workers are assigned to that function without executive responsibility, except for work closely related to their research.

6. As data are seldom available by which most questions of general administration can be treated with scientific rigor, it is usually necessary to include an element of judgment in the final decision. The function of the analysis is often to rule out some possible decisions and to modify in detail the decision finally adopted rather than to secure a logically inevitable "right answer."

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CHAPTER V

RESEARCH FOR MERCHANDISING AND SELLING [1]

THE principles of scientific management as formulated by Taylor are applicable to marketing operations, but it is perhaps his first principle—science, not rule of thumb—which comes nearest to being applicable in its literal sense. The only qualification necessary in this case lies in the limitations of the word "science." Market data are inexact data, at best, and hence their use, while it has scientific elements, belongs in the category of those less precise sciences in which, after all has been done to insure accuracy, much remains still uncertain and subject to human judgment. Much advance has been made over the complete dependence on "rule of thumb" formerly universal in marketing operations, but it is necessary to confess at the outset of our discussion that the scientific element in marketing is a relative rather than an absolute one.

Not only are these data inexact, but for some markets they are so incomplete as to be of only limited use. Nevertheless, even where the facts about markets are scarce, difficult to obtain and inaccurate, the experience of those who have used them has been that the technique of market planning gains by their use; and as the data improve, it is to be expected that both the actual material and the skill in the use of it will show betterment.

Any market study for any product of voluntary use to be sold for an appreciable consumer price involves not only the presence of people but also ability and a disposition to buy the product offered for sale. By the law of averages it may, and frequently does, happen that the quantitative population figures alone furnish a satisfactory guide to the qualitative factors represented by ability and inclination to buy. But when these qualitative elements can be measured or even judged by reflected data, the mere enumeration is that much more valuable.

Brute force in selling will accomplish much, as truly as it will in any other form of effort. But as sales effort becomes less dependent on brow-beating a customer and more dependent on serving him by virtue of a real knowledge of him and of the motives that control his buying activities, the greater will be its value to both buyer and seller.

[1] By Paul T. Cherington, Director of Research, J. Walter Thompson Company, New York; Professor of Marketing, Stanford University, Calif.

It is indispensable, of course, to know and assemble all the essential facts about the number, geographic distribution and economic status of customers or "prospects." But the point I want to make clear is that these have to do only with *ability* to buy. Unless these facts are supplemented by knowledge of resistances, susceptibilities, habits, prejudices, customs, buying motives and the utilization of these—which affect the inclination to buy—only part of the truth about the market is known. With these factors analyzed, marketing is largely a matter of skill. With quantitative data only, it must be largely a matter of brute force.

Sales managers have, in the United States, the largest and richest contiguous area on the planet which may be regarded as a single market. In some ways, it is a unified market, but notwithstanding its unity in the matter of language, monetary system, transportation facilities and commercial customs, it presents wide variations in detail and enormous diversity in buying power as well as in the nature of the people and the facilities by which they may be supplied with goods.

Until within a few years the buying capacity of this market, as applied to the sale of the products of any one concern, could be measured with sufficient accuracy by any good thumb-rule. The National Cash Register Company, for example, is said to have based its sales plans quite successfully for many years on an estimated annual consumption of one cash register for each four hundred people. Other concerns for years did a satisfactory business on similar rough general approximations of consuming capacity.

But in recent years the shortcomings of such general averages have been increasingly apparent. They have required so many local adjustments that they have long ago ceased to be even approximate bases for the construction of sales quotas. Within the past ten years many new suggestions have been tried out, and within the past five years substantial progress toward more accurate methods has been made.

There are few studies in this field which are not obliged to take into account one or more of the non-political bases for subdivision of population. These are as numerous as the whims of human impulse, but often they are more powerful influences than nationality. The markets for some products are determined by the economic status of the people. Silk underwear, for instance, may be ever so much desired, but for most people, under present circumstances, it is a luxury not practical for general use. Other markets rest on habits and customs; as, for example, market preferences for brown eggs in Boston and for white eggs in New York. Others are dependent on prejudices, such as those which account for the difficulty of selling certain cuts of meat. Climatic conditions are another factor; mufflers and ear tabs

sell briskly in New England, and not at all in certain other sections of the country, equally cold but with less humidity.

Racial influences are among the strongest factors determining markets. The 978 foreign-language newspapers published in the United States bear evidence of the importance of racial cleavages. The composite nature of the population is illustrated by this as it is also by the more familiar facts that in New York City there are more Irish people than in Dublin, more Jews than in Palestine, and more Italians than in Rome. The 800,000 Italians in New York, for instance, are served by 1,933 Italian grocery stores and 204 Italian drug stores—more than all the stores of these classes in some entire states. The foreign-born population of the United States is one-fourth of the total and in New York State the foreign born is one-half. Over 70 per cent of the population of New York City is either foreign born or of foreign parentage.

The United States has about one-quarter as great a population as Europe in an area approximately equal. The chief contrast is that our races are mixed together in forty-eight states united in a federal government, while those of Europe are held separate by languages, tariffs and other factors in forty-one distinct countries.

It is seldom that any one of these factors determining markets operates alone, although it is not uncommon for one to stand out conspicuously above the others as a controlling influence. Moreover there is none of these effective restraints on markets which can be regarded as permanently operative. All market studies are confined largely to the present tense.

The market for snuff gives a concrete instance. The output of snuff in this country is about 38,000,000 pounds a year, and it is increasing. Scottish and Norwegian snuffs are sold among the peoples descended from those two stocks, illustrating racial influences. The mountaineers of Kentucky and Tennessee still pursue the habits which were general a century ago, illustrating the influence of established habits. Climatic influences also doubtless have something to do with it. But the present limits of the market may be only temporary. The mournful literature of a century ago is full of sorrow over the spread of the snuff habit among women very much as our own scolds at the spread of the cigarette habit—regarded by many people as more harmful and more disgusting than snuff-taking. Similarly, the annual output of plug tobacco, which amounts to over a pound for every man, woman and child, is at present confined to consumption by a relatively small part of the population. It may spread to Fifth Avenue and other select circles now using other forms of tobacco, but for the pres-

ent its market is mainly among men who spend most of their time out-of-doors.

Any form of technical equipment, such as machine tools, offers an example of a product whose market is determined by the nature of the article and the uses to which it may be put. Neither great social change nor many of the other factors determining the markets for consumers' goods are likely to affect materially the influences which determine the actual or potential market for such products. Economic depression may postpone purchases, and competition may cause shifts from one specific machine to another, but the market remains fairly stable and can be measured by almost purely quantitative standards.

The complexity of the market factors and their constant shifting make the sale of consumers' goods peculiarly dependent upon influences beyond internal control. Plant expansion, the acceleration or retarding of the rate of production, the direction of sales pressure and all the other internal adjustments which must be made following shifts in the market (whether those shifts may be natural or induced) all require time. A change in a market which necessitates months of work before production is adjusted to it may occur almost overnight. Conversely, changes in conditions of production have sometimes produced changes in markets which have been long in working out. The interrelation between the problems of production and marketing have grown more intimate year by year. A relatively short time ago almost any manufacturer could sell goods up to the capacity of his plant by appealing to any convenient portion of the possible market. But, with the growth of plants in both size and number, the sharpened competition with other producers of similar products, substitute competition, and with the increased scattering of response due to multiplied pressure, it is no longer possible to depend on getting adequate results from efforts to reach a market without a factual background.

The greatest difficulty in setting up a sales quota is to find a satisfactory compromise between detail and generalization. Many beautifully constructed quotas have groaned terribly in operation, or failed to work altogether, because they were too intricate or too detailed. Others, on the other hand, have put the sales force into a state of ill-natured rebellion because they were incompletely worked out or were founded on facts inadequately established.

The best service a quota can render is as a current measure of performance. It is like the golfer's "par for hole." For this purpose, it is at best a balancing of many factors—buying possibilities of the market, and such others as experience has shown to be significant.

One of the earliest of the widely accepted suggestions for indicating buying power by counties was that developed by the Curtis Publishing Company under the direction of their Research Director, C. C. Parlin, in which they based the buying capacity, first of states and then of cities and finally of counties, on the combined circulation figures of their three publications—a woman's magazine, a popular weekly and a farm magazine. These three publications, operating in three distinct fields, had for several years been consistently at work building up circulation of these three types. These circulation efforts constituted a process of selection of three well-defined types of people which had been carried on consistently on a large enough scale and over a long enough period to result in characteristic selections from the total population. These figures have been widely used during the past five years and have proved to be of real value in sales-quota construction.

A similar selection has been made use of by the Crowell Publishing Company. But the Crowell organization has pushed the use of this type of figures a step farther by combining them with other figures indicating the accessibility and purchasing power of the country by counties. Under direction of Dr. J. H. Hayes this work during the past year has been still further developed by making use of the figures on incomes prepared by the National Bureau of Economic Research, and the estimates of purchasing power by counties prepared by Mr. H. G. Weaver of the General Motors Corporation. With these in combination Dr. Hayes has developed a set of figures covering effective incomes by counties which has proved to be of great value in sales-quota construction.

Another line of effort which paralleled these in a measure, in point of time, has been the working out of trading centers. In this work the two most conspicuous contributions have been the list of 657 trading centers worked out by the International Magazine Company under the direction of F. D. Wood, and the figures covering eighty-one cities of 100,000 population or over combined with the population and purchasing power figures for the surrounding territory covered by a leading newspaper in each of the cities. This is known as the "Study of All American Markets," and was prepared by the 100,000 Group of American Cities in 1928.

With figures available for counties, and others for the larger and more important trading centers, the next step in the development of sales-quota methods was an attempt to group these county figures about the figures for the centers to which they are tributary. The principle of this is simple and rather obvious, but its practical working out is full of difficulties. To the further practical development of

this idea the J. Walter Thompson Company has given much attention during the past three years.

Perhaps the most serious difficulty in this work is that growing out of the vagueness of the term "tributary territory." There are, for example, about 180 cities in the country which are primary grocery jobbing centers with large grocery jobbing houses; but, taking large centers and small ones together, there are 567 centers with grocery jobbing houses of substantial size. One of our first efforts was to group about these 567 centers the territory more accessible from those centers respectively than from any others. In revising this work for publication, the Bureau of Domestic Commerce of the Department of Commerce regrouped these territories about the 180 primary centers alone.

Either plan is effective for groceries, but neither grouping works wholly satisfactorily for drug products. With proper allowances for the large center jobbers operating on an interstate basis there are 205 drug centers with quite a different grouping from that for groceries.

Again, for goods sold to the dry-goods and department-store trades, the picture is very different from either of the others. There are 681 places having large department stores, and 632 additional places with smaller ones. About these places it is possible to group surrounding counties in retail shopping areas which will have few exact parallels with the areas for jobbing either drugs or groceries. The J. Walter Thompson Company has prepared, and published in 1928, a detailed tabulation of these retail shopping areas for the entire country.

By constructing in the manner thus outlined a series of subdivisions of the country into various types of homogeneous areas, or markets tributary to centers, it might be possible to find a number of centers appearing on all or several of the lists which would then become a recognizable group of general trading centers. But in the meantime groupings of trading areas about recognizable centers for the various individual trades seem to offer the best results.

Great progress has been made in the development of figures for use in sales quotas. The quantitative figures have been increased in variety and trustworthiness; qualitative figures which give some idea of purchasing power have also been made much more useful; and finally, the grouping of these figures in conformity with the sales practice and experience of the individual concern has shown marked advance. Instead of measuring sales in a given place merely by comparison with the population of a political group, they are now being measured more nearly by the people who ought to be reached from that place with due consideration of their ability to buy.

In addition to these studies of markets in general, there have been made during the past ten years an ever-increasing number of studies of markets for specific commodities or of special marketing methods. Most of these, of necessity, are of a confidential character so far as their details are concerned, but some indication of the character of studies of this kind may be given.

For example, a manufacturer of automobile accessories found that while he had thousands of customers on his books, a dominant percentage of his business was coming from less than one-tenth of the total. A careful study revealed the geography and commercial nature of a new scheme of customer selection which gave him adequate representation, while at the same time it enabled him to eliminate a large number of unprofitable outlets. And all of this market study was preliminary to a revised advertising appeal. Again, a maker of three types of furniture found that he was making little headway in expanding his market for the one of the three on which all his advertising effort was being concentrated, while the unadvertised lines were giving him a larger profit per item sold. By a recasting of his distributing structure, careful selection of outlets and a shift in his advertising emphasis, the business in all three lines was given new life with a substantial increase in both sales and profits. In another case two concerns in the same lines merged, one making a low-priced product and the other a medium-priced product of a kindred sort. Advertising of the medium-priced line under the joint name greatly increased the sales of the low-priced product while it virtually killed the sale of the medium-priced line. Before success was attained it was necessary to start the medium-priced line with a new name wholly separated from its low-priced colleague, letting the low-priced article take all the benefit of the elevated market created by the joint name.

When the market for fresh yeast for home baking began to feel the inroads of factory-baked products, a new market for it was found by making known the health-giving properties of this form of food eaten in its uncooked state. The electrical industry, railways, makers of food products, drug sundries, household appliances and numerous other lines of business have come to recognize the necessity for shaping their approach to the American market in the light of established facts rather than on their desires or on the "strong arm" methods of some of the successful market exploiters of over a decade or two ago.

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CHAPTER VI

RESEARCH FOR CLERICAL OPERATIONS[1]

One may ask whether there is need for research in the field of clerical operations. The answer is immediate and emphatic. In the United States there was expended in 1927 for clerical wages alone about $4,960,000,000. This great sum of money was expended for labor which was largely indirect and which must be added to the cost of product as a part of the general figure for burden. Research in this field produces results both in lowered costs and improved workmanship; it is common practice to secure expense reductions of from 25 to 50 per cent of existing wage costs. Such a percentage applied to the national clerical expense produces an astonishing figure which represents our national waste through use of unscientific office methods.

For illustration: in the year 1927 one large American corporation made economies in the operation of its offices which exceeded $200,000. These economies were the direct result of analytical research of organization and method. The cost of the research, together with the cost of the record keeping which resulted, was about $12,000 for the year. The economy was the result of waste-saving methods or systems, accompanied by financial incentives to employees for better production. The increased payments to employees were about $40,000 for the year, and the net gain to the corporation, after deducting payment to employees and the cost of doing the work, was about $150,000. The cost of the research and record keeping was about eight cents of every dollar that was saved.

Figure 1, representing the actual case of an office involving several hundred employees, is a graphical illustration of the effect on both production and earnings of the establishment of standards based on such research as is described in this chapter.

Assume that we have the problem of the reorganization of a typical medium-sized American office. There are about one hundred employees working under the direction of the corporation secretary, or possibly of a bookkeeper. The furniture, files and so on are the result of occasional haphazard purchases, and little or no planning for the future has been attempted. There is some office machinery: typewriters, bookkeeping machines, a multigraph, a letter opener and possibly tabulating machines. In all probability both furniture and machine pur-

[1] By Walter D. Fuller, Secretary, Curtis Publishing Company, Philadelphia.

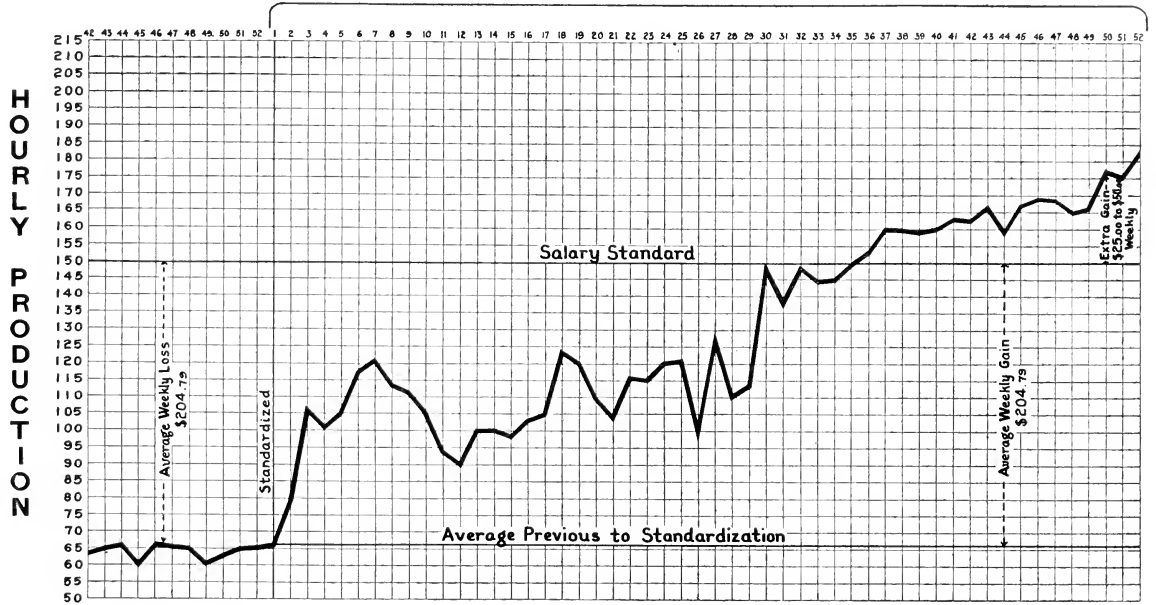

FIG. 1. THE RESULT OF RESEARCH FOR STANDARDIZATION OF CLERICAL OPERATIONS

chases have been the result of clever selling by a specialty salesman and not the result of analysis and planning on the part of the office executives.

Let us assume that the force consists of about ten stenographers doing more or less mixed secretarial and stenographic work, five correspondents, ten bookkeepers, thirty record clerks taking care of sales records and the like, five file clerks, ten statistical and payroll employees, fifteen persons on direct mail circularizing work, and a small group of miscellaneous employees such as messengers, reception clerks, telephone operators and secretaries.

Some company executive feels that all is not right and in the course of time the office comes under his control. How, then, shall he proceed to study his office and to make the needed changes?

All reorganization that deserves the term "scientific" must move along certain broad lines. There must first be the determination of the analytical factors, which include the history, the problem and the facts. Following this analysis, methods in vogue and others that may be devised must be tried experimentally, measured and valued, and the good sifted from the "not-so-good" and bad. These experiments must cover such things as office management, materials, personnel, methods of work and instructions. Finally the best methods must be installed and made permanent through proper organization, careful scheduling and detailed planning.

In accomplishing these results the first duty of the analyst is an initial survey and write-up.

Initial Survey and Write-Up. It is impossible for any one to change an organization intelligently unless he thoroughly understands the work, the aims and purposes of the office. Experience has proved that there is but one way to be certain that a person has such knowledge. The way is not easy and involves laborious work, much of which may seem trifling, but if this work is not done painstakingly and carefully, then the job of real analysis will never be accomplished.

Often one hears executives say, "I am interested in the broader phases of the work—the detail does not interest me and I do not know or trouble with it." Such a statement indicates a fundamentally wrong attitude, and unless it is changed no really constructive program can be attempted. It is not necessary for the executive to know permanently each detail of the affairs of his office, but at the beginning he must know them in order to lay out the organization. In this layout he can provide controls which will keep him in touch with the important details, and which will take but a small portion of his time. Another reason for requiring fundamental knowledge is that a chief who does not know will never have the full confidence and

respect of the workers, and in the office as in the factory, it is leaders and not drivers that are needed.

It is necessary first to analyze the purposes and aims of the office—what is being accomplished and why. The analyst should start by determining these facts and setting them down on paper. He must then study and write up in detail an outline of the actual work of the office as it moves to accomplish these ends. This write-up must be logical—presenting all the facts—and must be a connected story; not merely a collection of unrelated descriptions of the work of individuals. The following items are merely indicative: history and ideals; aims for the future; office arrangement; space, light, heat and ventilation; personnel of workers, length of service, health and probable future business life; methods of payment; equipment; description of work; use of machines with costs; necessity of each detail as it affects the end to be accomplished and its cost; study of seasonal conditions; flow of work; production records and costs; individual production, wage and cost per unit; description of any experimental tests already made with results.

The purpose of this write-up is to force the analyst to make a complete study of conditions as they are, and to compel him to work out the necessary correlation and coordination which must exist among activities in a well-managed office.

The Constructive Write-Up. As the initial write-up progresses, the analyst is certain to discover bad system; that is, illogical situations and disconnected and partially unnecessary activities. It is also probable that many of the methods in effect are the result of the opinions of the management rather than the result of thoughtful scientific experiment. He must therefore now begin the write-up of an ideal office. He must set down his ideals and aims and then plan to move in the most effective and economical way to accomplish them. The initial write-up was a reporting of facts as they were. This constructive write-up must disregard present limitations and difficulties and must attempt to lay out an ideal condition. It must accomplish the essentials in the simplest way, arrange for the most efficient office layout and equipment and standardize the methods of work as far as possible. It should determine the unit operations and production units, and it must provide means for securing a proper record of production, times and costs.

In office work the "unit operations" are such things as taking dictation, writing dictated letters, writing phonographic letters and secretarial work. The term "production unit" indicates the unit by which the production of an operation is measured. For the hypothetical office assumed for illustrative purposes in this chapter the breakdown

of operations and production units will probably be something like that given below, although these outlines are purely indicative and explanatory—every office will naturally differ in details from every other:

Operation	Unit
	Stenographic
Taking dictation	None
Writing dictated letters	Inches or strokes as measured by meter on the typewriter
Writing phonographic letters	Same as above
Typing	Same as above
Cleaning machine	None
Secretarial work	None
	Correspondence
Dictating letters	Time consumed or letters dictated
	Bookkeeping
Handling mail	Letters handled
Posting items	Items posted
Addressing forms	Forms addressed
Operating machine	Items handled
Making shipping orders	Orders finished
	Records
The operation will vary as work of the office varies; perhaps there will be:	
Posting sales records	Items posted
Mail opening	Letters opened
Tabulating	Items handled
	Filing
Filing letters	Letters filed
Consulting letters	Letters looked up
	Statistical and Payroll
Will vary according to the office work	May be difficult to determine but can usually be done
	Direct Mail
Folding circulars	Circulars folded
Machine operation	Meter revolutions or items
Hand addressing	Pieces addressed
Enclosing	Pieces enclosed
Stamping	Pieces stamped

The determination of operations is usually a simple matter. To decide what the production unit shall be is usually more difficult. In typing, letter filing and simple circular work the unit is obvious and

easy, but in bookkeeping and intricate clerical work it is more difficult. It will sometimes be necessary to have many units and to establish a relationship between them based upon their difficulty so that they may all be reduced to one common denominator.

The records pertaining to an operation will show the amount of production in terms of the production unit per unit of time.

This constructive write-up, like the initial one, must actually be written and must be a complete and connected story. It should go into the costs of the new methods (estimated if necessary) and must make clear the advantages of the proposed new plan. It must begin with a clear statement of the reasons for the office and the aims and ideals which are to be accomplished. Everything undertaken in this write-up must be for a purpose and this purpose must be a real one that can be demonstrated as a genuine need. In this write-up the analyst must divest himself of all prejudices and must constantly ask himself such questions as the following: Is this need demonstrated? Has this method been proved by experiment? Is the extreme accuracy of this method worth its cost? Is not the checking and inspection of this method really ineffective and does it not increase cost beyond its value? Exactly why is this particular thing done? It is particularly important that mere impressions of the necessity for methods and actions should not be accepted. Everything must bear the scrutiny of fundamental investigation—frequently of experimental trial.

Once this idealized plan is written, it must be compared with the practical situation, and such modifications must be made as circumstances compel. These modifications may be temporary or permanent. Then the best means must be determined for making changes in accordance with the plan. Radical changes usually have to be made gradually; the whole subject should be gone over and the best method of approach adopted. The motto "Evolution, not revolution," applies particularly to changes in office work. Violent changes in office routine are rarely advisable. It is much better to make the moves gradually, but none the less steadily. Such a program, however, requires that the moves should be planned in advance and that the whole reorganization should be the result of studied effort. As the new plan goes into effect, it is important that written instructions should be issued for each activity, that employees be coached in the ideals and aims of the office, and that they be stimulated to develop and suggest their individual ideas for betterment.

Close personal supervision must be given during this period as there will be a tendency to swing back to old and careless methods. Gradually the new plan will be accepted and establish its habit patterns. A few changes in personnel may be necessary but most employees will

accept the changes, particularly if they respect the executive and understand the purpose of his plan and its value to them.

Illustrative Investigations. The initial survey and write-up gave the new office manager a picture of conditions as he found them. The constructive write-up is essentially a description of the new way in which the office work is to be done. We have said that this constructive write-up has been determined at every point by analysis of records, experiments and other means of determining most suitable methods of performing operations. It is now our purpose to give one or two illustrative cases of office research, representing the detailed determination of facts in the plan.

In the first place it should be observed that considerable research has been done in the field of office management and its results are available in various publications. It is not necessary that an office manager duplicate these investigations. For example, the New York State Commission on Ventilation has made an extensive study of ventilation in schools and the data are applicable to office situations.[1]

The laboratories of electric lighting companies have made investigations of office illumination, and minimum standards have been formulated. Special types of desks for various kinds of office work have been developed by experiment, and these are far superior to those generally in use. The investigations of Professor Sabine, of Harvard University, have developed several types of sound-absorbent material which diminish reverberation and consequently the fatigue of noise in office work. The Rogers Laboratory of Physics, Massachusetts Institute of Technology, has investigated the work required to operate several makes of typewriters.[2] Mr. Max Freyd, of the Personnel Research Federation and the Retail Research Association, has done considerable work in the development of scientific methods of selecting workers for particular vocations. Other data of these kinds are available to office managers and should be utilized to save unnecessary duplication of research.

But the fact still remains that the greater part of the problems pertaining to any particular office is peculiar to that office, although such problems as heat, light, ventilation, and the characteristics of some special kinds of equipment may be resolved by reference to recorded researches. The operations peculiar to a particular office, such as the flow of work, the arrangement of desks and other facilities to accommodate the flow of work, and the method of performing particular

[1] *Report of the New York State Commission on Ventilation,* New York, E. P. Dutton and Company, 1923.

[2] *Transactions of the American Society of Mechanical Engineers,* Vol. L., No. 29, p. 29.

operations, require special investigations and the formulation of special standards for each and every office.

Even with respect to office machines the claims of manufacturers should as a rule be accepted with a great deal of caution, for the success of a machine in one office is by no means proof that it will be equally successful under other conditions. The following actual test of bookkeeping machines will illustrate the possibilities of research along these lines:

A concern had practically decided upon one make of machine as the best for its requirements. The salesman of the machine manufacturers had estimated that eighteen machines would be needed, at a cost of $22,000. The amount involved, however, influenced the concern to have a scientific test made of several machines before finally deciding. Four leading manufacturers were asked to send machines—we may distinguish these by the letters A, B, C and D. Certain test conditions were submitted, to which all the competing manufacturers agreed.

This test lasted for a period of six weeks, and the result was that machine "A" showed a record that placed it—on an average of all tests—well ahead of its competitors. This was not the machine at first decided upon by the department heads; the one they had favored before the test ranked third in the test.

In addition to this, it was found that the record made by machine "A" necessitated the hiring of but nine operators, nine of the "A" machines being found sufficient for the needs of the concern. Furthermore, machine "A" cost but $1,000, while the one decided upon before the test cost over $1,200, and eighteen of these machines, necessitating eighteen operators, had been recommended.

The savings resulting from this research may be conservatively figured as follows:

Cost of 18 machines originally considered	$22,000
Cost of 9 machines with best record	9,000
Savings on machines cost	$13,000
Wages of 9 operators saved per annum	9,000
Total saving first year	$22,000
Cost of test—about	2,000
Net saving first year	$20,000

It should be noted in addition that the saving on operators would continue year after year.

The following is a typical example of the setting of a standard on a decidedly non-repetitive job—checking invoices with orders.

The job was divided into five elements, as follows: (1) place papers and underline branch name; (2) check items; (3) fill in blank on order; (4) fill in blank on jacket; (5) draw line on order and replace papers. In addition, there were the elements of exchanging a finished job for a new one and recording the amount of the finished work on the office production record.

There were seventeen main classifications of material, on which records covering a representative period were kept and the results tabulated as follows:

TABLE 1

KIND OF MATERIAL	NUMBER OF ORDERS	NUMBER OF ITEMS	AVERAGE NUMBER OF ITEMS PER ORDER	PERCENTAGE OF ALL ORDERS
Class a.....	83,560	137,166	1.6413	9
Class b.....	25,324	101,680	4.0152	3
Class c.....	101,965	405,280	4.8574	11
Class d.....	154,661	622,550	4.0251	17
etc.				

It is obvious that the modal times for Elements 1 and 5 will always be uniform for all classifications. By time-study observation it was determined that a satisfactory time value for Element 1 was .06 minute, and for Element 5, .05 minute.

Elements 2, 3 and 4 vary according to the condition of the individual order. To determine Element 2, 3953 items were checked during the observed time of 229.01 minutes or at the rate of .06 minute per item. This value is multiplied by the average number of items per order in each classification in order to get the time value of Element 2 for each classification. For example .06 minute multiplied by 1.6413 gives a value of .10 minute for Class a, etc.

Element 3 and Element 4 consist of a larger number of variable parts. It was therefore necessary to make separate observations and compute averages in order to get at their value. A tabulation of the results yielded this information. (See Table 2.)

The determination of allowances for change of job and recording finished production—including a factor covering occasional cases of multiple orders matched with the invoices in one jacket—was made in the same way, with these results: .03 minute of allowance time for Class a; .03 minute for Class b, etc. (See Table 3.)

TABLE 2

KIND OF MATERIAL	NUMBER OF JACKETS STUDIED	TOTAL TIME FOR ELEMENT 3 (MIN.)	AVERAGE TIME FOR ELEMENT 3 (MIN.)	TOTAL TIME FOR ELEMENT 4 (MIN.)	AVERAGE TIME FOR ELEMENT 4 (MIN.)
Class a.....	173	18.87	.11	42.01	.24
Class b.....	109	17.70	.16	29.32	.27
Class c.....	201	25.60	.13	58.57	.29
Class d.....	149	18.31	.13	38.83	.26
etc.					

A summary tabulation for the whole operation up to this point, plus an allowance for unavoidable delay taken from "Curves of Unavoidable Delay Factors," [1] was then prepared as follows:

TABLE 3

KIND OF MATERIAL	ELEMENT TIMES					ALLOWANCE TIME FOR CHANGE OF JOB, ETC. (MIN.)	TOTAL TIME (MIN.)	UNAVOIDABLE DELAY TIME (MIN.)	TOTAL STANDARD TIME (MIN.)
	1 (min.)	2 (min.)	3 (min.)	4 (min.)	5 (min.)				
Class a..	.06	.10	.11	.24	.05	.03	.59	.23	.82
Class b..	.06	.24	.16	.27	.05	.03	.81	.30	1.11
Class c...	.06	.20	.13	.20	.05	.03	.85	.31	1.16
Class d...	.06	.24	.13	.26	.05	.02	.76	.29	1.05
etc.									

It will facilitate the work of record keeping and computation, and improve the general understanding of the standard task to have the rate expressed in terms that will cover all classes of work. This may be done by weighting the standard for each class according to the percentage of orders in that class (See Table 1.)

The total of this last column divided by the total of the percentage column (100) is the standard time to be allowed per jacket of any classification; in this case, 1.11 minutes per jacket or at the rate of fifty-four jackets per hour.

[1] Merrick, Dwight V., *Time Studies for Rate Setting*, New York, The Engineering Magazine Company, 1919.

TABLE 4

KIND OF MATERIAL	PERCENTAGE OF ALL ORDERS		STANDARD TIME (MIN.)		WEIGHTED STANDARD TIME (MIN.)
Class a	9	×	.82	=	.0738
Class b	3	×	1.11	=	.0333
Class c	11	×	1.16	=	.1276
Class d	17	×	1.05	=	.1785
etc.					

The general development of standards such as these, involving research and their application and use through incentive systems, has the twofold accomplishment of eliminating waste, expediting handling and lowering costs for the employer at the same time that employee earnings are increased—a definite goal from the very beginnings of scientific management, but only now being attained on a considerable scale in office and clerical operations.

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CHAPTER VII

RESEARCH FOR PRODUCTION [1]

THE research of the management engineer, the objective of which is discovery of standards to serve as dependable factors of calculation in planned control of production, is the subject of this chapter. However, attention must be given briefly to that environment of research in pure engineering within which the management engineer works and which gives him his facilities.

Basic Production Research.—The size of industrial enterprises has so increased that many of them can afford to carry the cost of specialized departments engaged in research in both pure science and applied science. It is necessary only to refresh the reader's memory by citing such enterprises as the American Telephone and Telegraph Company, the General Electric Company, the Westinghouse Electric Company and the Western Electric Company in electrical engineering; the leading manufacturers of automotive vehicles in mechanical engineering; the Standard Oil Company, E. I. du Pont de Nemours and Company, Parke Davis and Company and the H. K. Mulford Company in chemistry; and by citing such commodities as Mazda bulbs, the Wright engine, Duco, and radio tubes, condensers and transformers.[2] The work done in the research departments of these industrial concerns is of an intensity comparable with that done in universities, and the resources are far greater. The results of these researches of private industry are both shared and stimulated through government bureaus and numerous professional associations in mechanical, electrical, chemical and metallurgical engineering. These research facilities of industry have developed step by step with consumer demand for variety in goods and the opportunity for mechanization in their production made possible by increasing wealth, mass consumption and mass production.

[1] By George D. Babcock, Vice President Central Lumber Mills, Inc., Fletcher, N. C. The author desires to acknowledge the cooperation of Dr. H. S. Person in the preparation of this chapter.

[2] Replies from 599 manufacturing concerns to a questionnaire of the National Research Council in 1928 disclosed that these concerns were spending nearly $12,000,000 annually on research (*Recent Economic Changes*, p. 108). The Western Electric Company is said to maintain a staff of 2,000 research workers and to spend $8,000,000 annually on research activities; General Electric and General Motors each over $1,000,000 annually (*Iron Age*, September 1, 1927, p. 567).

The research departments of industrial enterprises are concerned not only with the discovery or invention of new commodities and facilities, but also with improvement of existing standard commodities and facilities. Research for the improvement of standard commodities has become a characteristic of medium-sized and small as well as of large enterprises. Much of the research by small enterprises is empirical in nature, although generally the research departments in the smaller plants are manned by men of technical training. There is scarcely a manufacturer of agricultural machinery, factory equipment, household appliances, chemicals and drugs, and many other commodities, which does not have its engineering unit constantly working on improvement in design, construction or basic production processes. Such varied basic research has become essential for survival to all except monopolistic enterprises. The invention of a new container tube cap may afford a differential advantage in competition to a manufacturer of tooth paste; or of a wrapping machine to a manufacturer of candy. This research we have characterized as basic production research. It yields the varied products and equipments of industry.

Production Management Research. The production research with which this chapter is concerned, however, is directed at discovery of principles and procedures of wise selection and adaptation of materials, equipment, tools, labor and processes, and of their more precise and economical utilization.

The controlling objective of such research is the discovery as a managerial problem of the best materials, subject to basic engineering specifications, from which to make products; the best choice of machines and tools for particular processes; the best miscellaneous conditions surrounding and influencing each process; the best coordination of all the factors which enter into production operations; and ultimately the establishment of these "bests" as uniform and known factors in terms of which plans are made, processes governed, capacities utilized and output and costs predetermined; in short, to permit production operations to be characterized as completely as possible by predetermination instead of chance.

The logical starting-point of management research in a particular plant is the product itself, for product specifications have an influential reach back into the nature of the production processes and their organization. At this point merchandising, engineering and production have a joint problem. The sales department is responsible for the marketing characteristics of the product—its adaptation to consumer use, and its quality and style; the engineering or equivalent department is responsible for basic materials, design and construction; but after these departments have made their contributions, there arise questions of

processing and cost which must not be ignored. Therefore the researches of the production department should unite with those of the marketing and engineering departments in a joint determination of final specifications of the product, which include not only the product itself but also containers, packing and total conditions of shipment.

These specifications having been determined, production research next gives attention to problems of procurement of the selected materials. Although it is the purchasing department which is responsible for establishing sources of supply and for actual procurement, the schedule of purchases—what, how much and when—is designed as a result of production research to meet the requirements of production schedules. The principal research problem here is to determine the safe least quantity of each item of materials in which capital is to be tied up without risk of loss through interruption of processes because essential items are not immediately available when required.

Then follow investigations of the problem of handling materials upon their receipt—methods of inspection, methods of storing according to the nature, quantities and frequency of issue of the various items, conditions of custody and routines of issue. Problems of handling worked materials and stock items of product are investigated in a similar manner. Investigations such as these pertaining to materials establish a factual basis for firm and economical control of materials, which is one of the corner stones of firm and economical control of processing generally.

Logically next is that group of investigations pertaining to the operations involved in processing. Among these comes first the general problem of flow of work with respect to each item of product, through the series of technically inherent operations. This problem will vary in its nature and complexity according to the difference in kinds and sizes of plants, according to whether processes are analytic or synthetic, items many or few, the machines multiple-purpose or single-purpose, the processing for stock or customer-order, and so on. These investigations should secure data which permit a most effective arrangement of the series of operations and of the equipment in space, and a quantitative adjustment of these, including not only the individual machines but also shafting, conveying apparatus and other types of auxiliary equipment.

This problem of general arrangement of the flow of work and the number and location of individual work places having been met, there then follows the investigation of each work place. Unless particular circumstances compel an exception, the work place first in series should be studied first, and the others in accordance with this sequence; for the reason that the final arrangement as a result of investigation of

the conditions at any particular work place frequently influences the conditions at the work place next in series, and should be effected before the latter becomes an object of study. If work place B is studied and standardized before work place A, the later study and standardization of work place A may so affect conditions at work place B as to compel a complete new study and standardization of work place B.[1]

These investigations, the object of which is to establish the best combination of conditions at the individual work place, are likely to be extensive in the range of detail, and some of the detailed studies may have to be intensive in character. Is the particular machine the most desirable among the models available for the predominant kinds of work done in the particular shop? If yes, is it in every particular most desirable or should it be more minutely adapted by redesign of some of its parts? Are its provisions for speeds, feeds and other adjustments most suitable? Is it desirable that its speed should be stepped up, and if so, how much? What are the necessary provisions for inspection and maintenance of the equipment? Are there adequate jigs, fixtures and other auxiliary appliances? Are the tools the most suitable and adequate? Does it receive the maximum delivery of power from the shafting? Or, is the dynamo adequate? Are there suitable arrangements for the temporary location of materials to be worked upon, and for the disposition of materials as they come off the machine? Are the conditions such in every particular as to promote efficiency of output and at the same time reduce the operators' efforts and fatigue to a minimum? What are the requirements as to training of operatives? These questions are only suggestive of the wide range of problems which are the object of research in management's attempt to standardize each work place so that it represents the best-known combination of conditions for the dominant processing for which the work place has been established.

The various work places having first been arranged in proper coordination, and then each standardized to insure the best performance of the characteristic operations of the shop, there next follows as a group of research problems the study of individual operations to be performed at the various work places. Although there has been a general standardization of work places for *types* of operations, there must now be particular standardizations and prescriptions for each *particular* operation, for operations within a type may vary to a greater or less degree in details.

Here is involved investigation of much the same kind of problems as were present in the preceding investigation which led to general

[1] Cf. Chapter XXVIII, p. 440.

standardization of the work places, except that now the question is, not what is the best range of feeds and speeds for the type of work to be performed, but, for example, what are the particular feeds and speeds for the performance of the operation of making item A 26. And so it is with respect to every variable involved in processing item A 26; and likewise with respect to item A 27, and every other item. Specifications are thus derived for the standardization of processing on each item at each work place. It is on instruction cards that these specifications are eventually recorded, as illustrated in Figure 35 (page 219).

It is at this point that time study enters as one of the measures—a most important measure—of suitability of conditions and methods of performing an operation. The first measure of suitability is of course quality—the performance of the operation so that it results in a predetermined quality of result, for if the predetermined result is not precisely achieved the method can never be "best." The second measure of suitability is avoidance of undue strain upon operator and equipment, for if these factors do not stand up, the result likewise can never be achieved. These two criteria having been met, then the measure by which the best remaining combinations of variables of condition and method are determined is the shortness of the time of performing the operation. Time is a major factor of wage cost under time-rate methods of wage payment; is an important measure of cost under nearly all forms of differential wage payment, and is a factor of capital investment cost under all conditions. Its importance as a measure of suitability of conditions and methods of performance in an enterprise in which success depends upon the maintenance of a difference between expense and income is therefore evident. Time study as the most important tool of process investigation will be given special consideration in the last section of this chapter.

These time measurements have another importance than that of determining the best operating conditions and procedures. As will be observed on the instruction card reproduced in Figure 35 (page 219), the time for each unit of an operation and for the operation as a whole is indicated in conjunction with the listed best sequence of performance units of the operation. This total of information not only serves the supervisor in planning and scheduling work, but it serves the operative in many ways: as a guide to the best sequence of unit elements in the performance of the operation; as a goal to aim at with respect to performance time; as information governing the basis on which wage contracts are made, and as information on which executive computation of plant capacity, costs and other items of executive interest have been computed. The worker is given

information concerning details of standards comparable to those possessed by the planning room which uses these data in planning and controlling operations. He has an understanding of just what is expected *before* the job is started. The laying of this information before the workers tends to insure accuracy and dependability in management's research processes and results for, although no one worker may possess as much information as the research group, the aggregate of information possessed by all the workers is sufficient to stimulate painstaking work on the part of the research group, or their careers as investigators will come to a timely end.

In this exposition, deliberately oversimplified for the sake of brevity, we have suggested the nature of the investigations pertinent to product; materials, their procurement, custody and handling; general standardization of machines, tools and work places with respect to types of operations; and particular standardization of each operation within any type. Let no reader think that these investigations so simply described involve other than prolonged and painstaking investigation and experiment. Perhaps the following summary statement of the problems involved in the development of scientific management in a shop will give a more impressive picture of the researches which are necessarily involved:[1]

1. Development of an organization plan for departments and subdivisions, defining authority, nature, scope and limitations of activities, and relations and responsibilities of each department;
2. Development of a lay-out plan of departments and equipment, to provide for the rearrangement when necessary, and to include provision for expansion and new departments in accordance with the organization plan;
3. Collection and codification of data relating to product;
4. Collection and codification of data relating to machinery and other equipment;
5. Standardization of machines and development of a maintenance system;
6. Standardization of tools and development of a tool-room system;
7. Development of a stores system;
8. Development of an order system;
9. Development of a timekeeping system to serve accounting purposes;
10. Development of a routing system, including complete planning in advance of work to be done in turning out product;
11. Development of methods to follow up and control work-in-process;
12. Development of time study, development and standardization of operations and operating methods and a pay system based thereon;
13. Development of a cost-accounting system.

Studies relating to the worker as a human being have become specialized and are left to the consideration of other chapters. But there

[1] Hathaway, H. K., "Logical Steps in Installing the Taylor System of Management," *Industrial Management*, Vol. LX, No. 2, August, 1920, p. 93.

still remains a group of shop researches imposed by the fact that the total shop situation, particularly as affected by environmental influence, is not always technically simple and may be now and then disturbed by variables which management attempts and hopes to avoid but for which provision must continually be made.

Among these contingencies is variability in the volume of work as determined by the success of sales efforts. What is the effect on production operations of such variability according to various degrees of variability? To set up a machine for a particular operation on a lot of product is a constant independent of the number of units in the lot. This constant represents a continually diminishing factor in unit cost of product as the lot size increases. Knowledge of its influence on time, cost and other production standards is important, and that influence must be an object of careful investigation.

Another aspect of what is a related problem is the question of investment in equipment, tools and labor. For what norm of capacity shall the plant be equipped and manned? What is the influence of idle equipment and labor on cost? What is the breaking point between the cost of investment in idle capacity and the cost of having peaks of production met by contracts with other plants? What should be the program of retrenchment for the time when sales decline; the program of expansion when demand increases? Such problems as these fall within the field of responsibility of production research.

Again; what is the effective safe and economical rate of improvement of facilities through replacement of depreciated equipment by new models, revision of details of operating procedure and education and training of the working force? Changes cannot be made by what the statistician terms continuous intervals; they must be made by discrete intervals. Scientific management seeks that economical balance between the advantage of stability and the disadvantage of obsolescence—*strives for a moving equilibrium*—as regards methods and skills as well as physical equipment. This point has been well explained by Carl G. Barth.[1]

> Before proceeding to any definite recommendations, it will be well to consider the objection so often raised to the adoption of standards of any kind—that standardization blocks the way for further development and improvement.
>
> If this were unqualifiedly true, standardization would almost be a crime; but if we adopt a standard merely as representative of the best a trade or profession knows of at any one time, with the understanding that as soon as a *decided* improvement is brought out a new standard will be adopted to parallel temporarily, and eventually replace, the former standard, the danger of stagnation will be obviated.
>
> Perhaps my idea will be understood more readily by reference to (Figure 2)

[1] *Bulletin of the Taylor Society*, Vol. XII, No. 6, December, 1927, p. 554.

in which the smooth curve *ab* tending toward the asymptote *cd* represents a gradual development with immediate adoption of improvements in any line toward an eventual highest possible attainment; and the broken line, whose corners 1, 2, 3, 4 and 5 lie in this curve, the only occasional adoption of such improvements, when these have attained enough importance to make it worth while to change from one temporary standard to a new one, both standards then being in use during the period of change.

To such problems, general and detailed, scientific management brings the pertinent resources of research, investigation and experiment. With respect to some, the investigative efforts are continuous, thorough and of the nature of genuine research; with respect to others, more in the nature of quick surveys. Which it may be depends upon the degree to which the problem is transitory or fundamental in nature, or upon the probable value of the results to the particular enterprise. While management is becoming more and more scientific, in that it uses more and more the methods of science in discovering

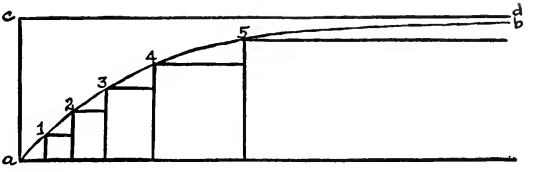

FIG. 2. REVISION OF STANDARDS BY DISCRETE INSTEAD OF CONTINUOUS INTERVALS

factual bases for decisions as to its conduct, it does not lose sight of the fact that it must be practical, and that research is either an expense which must yield a prompt surplus return, or an investment which must have the same outcome in the long run.

Time Study. Production utilizes all methods of research: the historical, as in the analysis and comparison of past with present records; the statistical, as in quantitative measurement of classified reactions to various operating conditions; and the experimental—the analysis and valuation of results of controlled variation in conditions. For instance, within the limits imposed by its nature—composition, size, weight, etc.—the location of an item in a stores room is likely to be determined by a statistical study of the comparative frequency of its issue over a definite period; the standard size of bins in a stores room by a statistical study of the size of the various items in order to discover a standard bin size which will accommodate the standard quantities of the greater numbers of items with least waste of space. In the search for that combination of work place, machine and tool conditions, and method of manipulation, which indicates the "best way of performing an operation according to the present state of the art," the

experimental method is employed. As has been indicated in the first chapter, the application of research, especially the experimental method, to discovery of the best method of *use* of facilities was undoubtedly Taylor's greatest contribution to a science of management. Before him generally methods had been developed by chance and imitation, and with respect to any particular operation, they existed in great variety as to nature and efficiency.

As we have already stated, the basic conditions involved in any "best way" are, first, maintenance of quality of product, and second, correspondence of the conditions and method to the aptitudes of available operators; but after these conditions have been met there remains with respect to practically every operation a considerable range of choices in which time is the dominant criterion of excellence. The first two requirements having been met, that set of conditions and method is preferred which requires the least time for the production of a unit of product. Time enters as a multiplier in many phases of the calculations of cost, and the smaller this factor the less the cost and the greater the margin between total expense and total revenue. It is this margin which ultimately determines in competitive industry not only the profits and the maintenance of the enterprise as a going concern, but also the scale of wages and the application of portions of the revenue to diminutions of the discomforts of labor. Furthermore, there has not been discovered any factor more omnipresent and useful, in the organization technically of the processes of industry and in the organization psychically of relations between the organic human groups in industry, than this factor "time."

To secure these high purposes time study must be painstaking, thorough and cooperative. Because it is easy to purchase a stop watch and go through the motions of making observations and analyzing the resultant data, the use of time study has spread with great rapidity and a large, if not the greater, part of it is of questionable value. Superficial time studies can be as destructive to operating control, accuracy of cost computations and agreeableness of human relations, as superficial measurements of a civil engineer can be to the safety and permanence of a bridge or a sky scraper. On the other hand, however, accurate time studies can be as useful to management and workers as accurate measurements to the designer of a bridge.

The literature of time study is now so adequate [1] that it is unnecessary for us to give attention to the technical characteristics of the stop watch, first constructively employed by Taylor about 1880, and of the micro-motion apparatus, adapted by Gilbreth about 1910. We shall give attention rather to principles of use applicable to both.

[1] Cf. references at the end of this chapter.

It is a common misconception that time study is a necessary or good means to discover useless or wasteful motions preliminary to standardizing a complex operation.

Such motions are best ferreted out by common-sense observations on the part of a person well versed in the trade, who has caught the right spirit, without any time study. The time study properly comes later, and may then be made by a person less expert in the trade; but no amount of mere time study of an unstandardized complex operation will directly lead to the elimination of its useless or wasteful motions. However, such time studies submitted to the scrutiny of a person well versed in the art may be that person's indirect method for detecting and eliminating useless and wasteful motions. Because of the misconception referred to, a lot of worthless time study is being made the country over by mere stop-watch men. Time study should not be taken up until conditions of machines, tools, materials and motions have all been properly studied in an everyday, common-sense and expert manner, and later standardized on the strength of the information thus gained.[1]

But after such general standardization has been effected by one who is expert in the trade and has a strong sense of arrangement and order, time study of the complicated operation as performed by various skilled workers will disclose opportunities for a greater degree of refinement in organization of the operation. This refinement of the operation itself is a by-product of time study; its major objectives are to give planning and control data by determining the time factor for each operation; a time base for the establishment of wage rates; time and method information for the guidance of the worker; and not least among the objectives, unit times for predetermination of the cost of changes in parts of the product, and of new products of the same type. Time study, insofar as it concerns general improvement of operating conditions and methods, does not give industry a cheap substitute for one having skill in the trade and a genius for order and economy.

Unit time study is more useful and in the long run more economical than over-all time study. By over-all time is meant the time of an operation as a whole. By unit time is meant the time of each indivisible component of the total operation. An over-all time is useful only for the operation studied and becomes but so much junk when the operation is changed in any part. It does not permit that refinement of standardization permitted by comparison of the unit times of various operations, and it does not serve to define and improve method. Unit times, on the other hand, although they are more expensive at the beginning and must be considered an investment to be amortized by their accumulation and subsequent usability, are incomparably more valuable. They permit the comparison, with respect to a given operation, of the unit

[1] Barth, Carl G., *Bulletin of the Taylor Society*, Vol. XII, No. 6, December, 1927, p. 554.

times of various operatives, and the discovery of a "best way" with respect to each unit. They permit informing comparison of one operation with another. And if properly classified and filed, a large portion of them may be used—thereby saving an equivalent amount of time study—in building up total times for an operation which is changed in some detail, or for new operations which have coincident units. On a given machine 75 or 80 per cent of the units of new operation B may coincide with the units of old operation A. The times of the coincident units of A, combined with new time studies of the 15 or 20 per cent of the non-coincident units of B, will permit the construction of an over-all time for B at a moderate cost. In the course of time, classified and filed unit times may furnish data for all but a small proportion of the units of any new operation. This availability of unit data is particularly valuable in case of a need to compute the effect on cost of a variation which may result from a proposed change of some part of a standard product—say from a five-bearing to a seven-bearing crank shaft. The computation of the effect on cost may in advance of actual work on the new model be made a practical certainty instead of a guess.

Unit time study defines and improves methods; it captures the methods of the best workers, refines them by the experiments of management, and perpetuates and makes them permanently available to all workers. As Taylor has put it, it is the greatest single tool for the "transfer of skill from management to men"; really from workers to management and then in more refined form from management back to the workers.

There is another important characteristic of these intensive time-measured studies of operations; not only are units of an operation made the units of investigation, but machine capacity rather than the individual operation may be made the object of study. As Merrick has explained:[1]

> . . . the distinction should be fully appreciated between the study of an individual operation on hand work, or on a machine, and a study of the operation of the machine itself. The first type of study would be represented, for instance, by a profile cut on a rifle part, while the second would be the study of the elementary motions in connection with the operation of a machine tool, such as a boring mill. The difference between the two classes of studies is at once apparent, for the first applies to work on a particular piece only, while the latter supplies information for fundamental operations on a given machine, and in this form the data may be used for all work within the capacity of the machine tool.

[1] Merrick, Dwight V., *Time Studies as a Basis for Rate Setting*, New York, The Engineering Magazine Company, 1919, p. xiii.

It was a fixed conviction of Taylor's that a table of such fundamental operation times for every standard machine would permit the construction of unit times and an over-all time for any operation, related to a specific product within the capacity of a machine, without a special time study of the particular operation. He believed that every manufacturer of standard equipment should provide every purchaser with a book of such standard times—something analogous to interest tables. So great was his faith in this ideal that as a demonstration at his own expense he undertook studies along this line. This enterprise had hardly begun when it was terminated by his untimely death in 1915.

While there is strong argument that such studies be made by the manufacturers of equipment, the argument is rather against their being undertaken by purchasers and users of equipment. Since Taylor's death changes in the design of machines and replacement of man-manipulated by automatic and quasi-automatic machines have proceeded with great rapidity. The rate of obsolescence is so great that fundamental studies might not be completed—certainly their cost not amortized—before the machines would be discarded. Nevertheless, with respect to equipment of which the permanence is reasonably assured, fundamental studies would in the long run probably be advantageous and economical.

Time study offers its chief usefulness in connection with the determination of standards for man-manipulated and multiple-purpose machines. It is in the operation of such machines that variability is ever present—variability in items, flow of work, operations, conditions, adjustments and labor skill—and the object of time study is to establish as far as possible known constants in place of unknown variables. In proportion as the status of a machine approaches that of an automatic, single-purpose machine through which there is a continuous flow of work, the opportunity for time-study standardization diminishes. In fact, with respect to this latter class of machines the time measurements are made in connection with the researches leading to the design of the machine by the mechanical engineer, and the results of these measurements—the equivalents of time study—are designed into the machine. Each of a series of such machines must have the time factors which are designed into it determined with reference to the time factors of all the machines of the series; so that the series becomes essentially but one huge synchronized machine. Therefore the development of automatic equipment in series is making it essential that the mechanical engineer engaged in the design of such equipment shall be management engineer as well; his design must be governed as much by conditions of use—for instance, volume of flow of work

as determined by analysis of orders—as by application of the principles of mechanical design.[1]

In many instances too little consideration is given by general management to the competence of those to whom time-study work is entrusted. There are really two groups of functions involved in time-study work. There is, first, supervision, involving the analysis of operations, the standardizing of flow of work and general conditions, the analysis of data, the making of allowances and the final determination of standard times and rates; and second, the making of observations involving manipulation of the stop watch. This latter function can be performed by a person of moderate experience; but its objective manifestations are so conspicuous that general management too frequently appraises the total of competence required in terms of this one function, and employs a person possessing this limited competence only. The supervisory function, however, is by far the more critical and requires competence of the highest order, identified in a quotation from Mr. Barth on an earlier page as requiring "a person well versed in the art" in contrast to "mere stop-watch men." The "mere stop-watch men" are only aids to a principal who must have had long experience which has developed a capacity for wise, far-reaching, practical judgments, and who must have a strong natural sense for arrangement and order.

There has been discussion concerning the type of workers who should be selected for observation. While there may be a reasonable variation in theoretical judgments among competent authorities as to whether the "one most skilled man" or "several highly skilled men" should be selected from the group in the shop (as a matter of fact skilled time-study men will get essentially the same results whichever is chosen), there is no disagreement among competent technicians on the proposition that an average man should not be chosen. Yet not a few writers, unacquainted with time study but appraising it as a social institution, argue that an average man should be selected as more properly representative of a group. However, experience has demonstrated that selection of the average man leads eventually not only to a practical nullification of any constructive results, but frequently to confusion and disaster. This is because times based on an average man, as so rated at the beginning of betterment of conditions and methods, are likely to represent the abilities of low-grade skill after betterment is completed; or put in another way, time standards based on a study of men rated highest at the beginning of betterment are

[1] Cf. Schulz, G. E., "Engineering in Management," *Bulletin of the Taylor Society*, Vol. XIV, No. 1, February, 1929, p. 39.

almost certain to correspond to the competence of average men after betterment is completed. This can be illustrated graphically.

In Figure 3, the curve X-Y represents the normal distribution of skills, as measured by performance time, before methods—acquired casually and by chance—have been improved by the development of scientific management. The curve X′-Y′ represents the normal distribution of the skills of *the same group of men* six or eight months later—after conditions and methods have been improved and training introduced. It should be observed that the prestandardization curve presents a wide distribution of skills with no marked modal group; but that the poststandardization curve presents a distribution of skills which are not so widely dispersed, are of a higher quality, and have a distinct mode. Now a time-study man who selects worker A, an

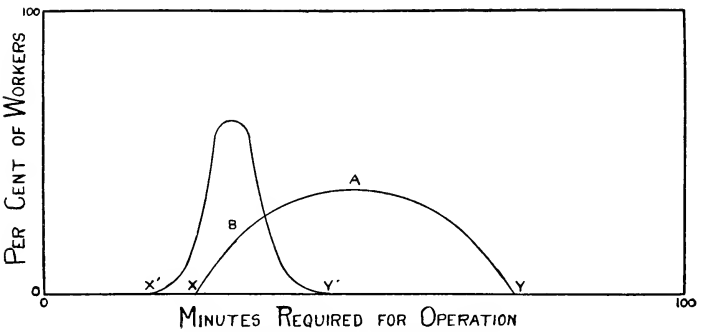

FIG. 3. THE DISTRIBUTION OF A GROUP OF WORKERS AS TO SKILL BEFORE AND AFTER IMPROVEMENT OF METHODS

average man of the prestandardization period, would after standardization be operating with standards corresponding to a low-grade performance in the X′-Y′ group; while if he selects worker B, a very high-grade man of the prestandardization period, he would after standardization be working with standards corresponding closely to the average ability of the group after betterment of conditions and methods. A standard based on worker A of the X-Y group would not be usable for the X′-Y′ group. Generally the safe rule is to study as many men as the particular operation requires, selected from among those most skilled and normal in temperament.

There is no fixed rule as to the number of workers to observe and the number of observations to be made. These vary according to the combination of factors in the situation; the economic importance of

the operation; the technical nature of the operation; the number of units in the cycle making up the operation; the length of time of units; the known efficiency of the worker and of the group generally, and the physical conditions affecting the work. An experienced time-study man will usually exercise a sound judgment based on consideration of such factors as these. One engineer has stated his general rule as follows:

> The longer the operation, it may be stated in general, the fewer the studies required, and vice versa. If the length of time consumed is five minutes, I generally make ten studies; if two minutes, fifteen studies; if one minute, thirty studies. For those of half a minute or less, sixty studies are required. On the whole it is better to have too many than too few, and perhaps it would be well for beginners to take twice as many as I have mentioned as my practice. A greater degree of accuracy will be assured.[1]

After a sufficient number of observations has been made the observation sheets will contain three classes of data: first, a description of the operation in every detail, in terms of product, machine, tools, conditions, etc.; second, figures representing the time at which for each observation each unit of the operation was begun and completed, the stop watch having been permitted to run continuously; and third, notes concerning variable incidents which influenced the times, such as the dropping of a tool or the breaking of a piece of defective material. Lapsed times are then computed from the running times; there will be a considerable number of lapsed times for each unit of the operation, depending upon the number of observations. The lapsed times for each unit are analyzed in the light of their average, median or mode, the dispersion and the influence of the variable incidents, and a standard time for each unit is determined. By addition of these unit-standard times an over-all time is computed, to which is added an allowance for fatigue and unavoidable delays. Space does not permit a discussion of the technique of analysis of observations and the computation of standard times, and with respect to these aspects of technique the reader is referred to the authorities listed at the end of this chapter. It is sufficient to observe that there is considerable variation in details of technique among time-study engineers, yet the final results of two men of equal experience and general competence will usually be practically identical, at least up to the point of determining the allowance for fatigue and unavoidable delays.

The allowance for fatigue and unavoidable delays is less submissive to exact determination by experimental and statistical analysis than the determination of the standard times minus that allowance. The fatigue factor in the allowance depends chiefly upon two factors in the

[1] *Bulletin of the Taylor Society*, Vol. XIII, No. 3, June, 1928, p. 160.

mechanical nature of the operation: the length of the operation cycle, and the relation of handling time (when the worker is doing manipulative work) to machine time (when the machine is working without worker manipulation). The allowance should increase directly with the proportion of handling time to total operation time, and indirectly with the length of the cycle. On the basis of these two factors Barth and Merrick have constructed a series of graphical curves, based upon many thousands of studies, from which standard allowances may be read for a wide range of machine-shop operations.[1] These same curves have been proved valid for the successive operations in a men's ready-made clothing plant.[2]

The factor of allowance for unavoidable delays depends chiefly upon the perfection of standardization of general conditions and of machine conditions prior to the time study, and upon the perfection of maintenance of these conditions. If materials are brought to and taken from the machine with precision, if the materials put into the machine run evenly as to quality, and if the machine and tools are maintained in perfect condition, accidental interruptions are diminished and the factor pertaining to unavoidable delays will be small. Where the reverse of these conditions prevails, the factor must be larger. It may be asserted that the extent of the allowance for unavoidable delays, above an obviously essential base time, is a very good measure of the effectiveness with which general conditions have been standardized and these standards maintained. What may be accomplished through precision of standards (including allowances for unavoidable delays and fatigue) and their maintenance as a basis of calculation is illustrated by the following incident in the writer's experience. During a period of 645 consecutive working days in a metal-working industry an exactly scheduled production was maintained, based on a schedule laid down at least five months prior to the date on which any lot of product was delivered to the shipping department. This involved the scheduling and keeping on schedule of over 8,000,000 machine operations.[3] This incident is cited to illustrate not only what may be done in the way of precise planning and scheduling on the basis of maintained standards, but also to indicate how maintenance of general standards permits precise time standards (including the element of allowances for unavoidable delays)—otherwise this record could not have been made, adhering to such a precise schedule.

When scientific management is first established in a plant it is

[1] Cf. Merrick, Dwight V., *Time Studies as a Basis for Rate Setting*, New York, The Engineering Magazine Company, 1919.

[2] Cf. *Industrial Management*, September, 1922, p. 173.

[3] *Bulletin of the Taylor Society*, Vol. IX, No. 6, December, 1924, p. 260.

customary to check standard times of operations by shop try-outs before the times are formally established as standard. Among thousands of standards, errors will be discovered by these try-outs, in which case new studies are made. But in a plant in which scientific management has been established for a considerable period and in which, although the products may change, the fundamental operation units remain the same, these try-outs eventually cease to be essential. Success in the establishment of new standards without shop try-outs is fair evidence that scientific management is firmly established and in particular that time studies have been made with precision.

Success in establishing sound time standards without the necessity of checking by shop try-outs depends obviously upon a file of classified dependable unit time-study data. In fact, it is such a fund of cumulative unit data that makes possible a high degree of managerial control in a dynamic industry. In such an industry the cost of a never-ending succession of complete and accurate individual time studies on new operations would be prohibitive on the ground of cost. But the accumulation of precise unit data permits an early amortization of the first investment and from then on a firm control of operations at moderate cost. Every new product or variation in an old product can be promptly brought under the control of time standardization; and as we have said earlier in this chapter, accurate estimates of cost can be made the basis of policy even before there is actual cost experience from making the new product. On the basis of such data also, a complete and accurate schedule of balanced equipment, personnel and material requirements can be constructed for any proposed extension of production of old or new items.

Furthermore, a file of standard time-study data, properly classified, will be very serviceable in the development of algebraic formulæ, to be used on operations where the variation in time required is chiefly influenced by physical characteristics of the work, of which there may be innumerable combinations in a given class. Properly and logically developed, formulæ have the greatest possibility for the saving of a standards department's time in the preparation of standard times, and consequently their use has been applied to a wide range of production operations. The possibility of their development and application in this way is a concern of research for production. Indication of the extent to which this has been done in one industry is found in another source,[1] and a statement from this work is significant. "A formula, above everything else, must give accurate time values. If it does not,

[1] Lowry, Stewart M., Maynard, Harold B. and Stegemerten, C. J., *Time and Motion Study and Formulas for Wage Incentives*, New York, McGraw-Hill Book Company, 1927.

it is practically valueless." Loosely constructed formulæ are dangerous, and are to be avoided in the same sense as over-all times, or time-study observations of poor grade.

In Taylor's day, time study and motion study were not considered separately; although he sometimes used the term "motion study," Taylor usually used the term "time study" to cover both. It was Gilbreth's adaptation of the use of the moving-picture camera in studying operations, with its emphasis on motion, which caused a separation of motion study as a distinct concept.

Constructive work on operations with many units in short cycles has been done by the Gilbrethian method. But generally industry has found attention to times rather than motions quite sufficient. It is an interesting fact of human nature that, given identical standardized conditions and following identical sequences of unit elements of an operation as set forth on an instruction card, a group of reasonably skilled operatives on any machine will employ essentially the same motions and perform the operation in essentially the same time. But when an operation is of such a nature as to require a characteristic "form" for performance—analogous to the form of a tennis player or pole vaulter—the micro-motion method is superior as a method of form analysis.

This characteristic of human nature—that, given identical conditions and identical instructions as to the best sequence of units of an operation, reasonably skilled workers will employ essentially the same motions and achieve the same times—is what makes practicable the development of new methods rapidly and without compulsion. There are many students inexperienced in industry who assume that when a new standard method and standard time for an operation are established, the management practically says to the worker, "You must do it this way and in this time, or you will be discharged." No one acquainted with the common-sense relations in a shop makes such an assumption. What the management says is substantially this: "With the facilities in the condition in which we have now put them and shall maintain them, and following the sequence of units here listed, any good worker can turn out the product in the time here specified. We have demonstrated this by experiment. It is on this demonstrated fact that we base our sales and production programs, delivery dates, costs, prices and scale of differential wage payments. We should like to have you learn to do it this way, and it will be to your as well as our advantage to do it this way." The interest and the self-esteem of the worker almost invariably stimulate him to comply with the new procedures. If he fails to meet the new standard it is usually because he is a misplaced worker—not skilled with respect to the particular opera-

tion. The point at which compulsion may be held to enter is in connection with the worker's realization that, if orders decline and retrenchment becomes necessary, those workers who on the record have failed to adopt the new methods will be the first to be released.

Not a little is being written nowadays concerning the desirability of workers' participation in making time studies.[1] As a matter of fact nowadays such participation is the usual thing, but it varies in form from passive consent to organized participation. In a shop in which the workers' experience has given them complete confidence in the management, participation will usually consist in a passive but completely informed, and usually an interested, looking-on. It is a mistake to think that the workers do not know exactly what is going on. Time studies are made in the shop where work is going on. Worth-while studies are made only with the complete understanding, approval and interest of the worker being observed. Other workers in the vicinity of the observed workers see and comprehend everything which is done. The procedure is a matter of discussion throughout the shop. When the standard times are finally announced, the workers' empirical judgments appraise them. There is little hesitancy in expressing doubt or even disagreement. Such is the procedure in a shop in which the management has the workers' confidence.

However, in a situation in which there is workers' distrust of management the securing of the necessary technical cooperation may have to be accomplished by formal organization of workers' participation. In the agreement between the organized employers and the organized workers in the Cleveland, Ohio, ladies' ready-made garment industry, there is a committee on standards, recruited from the workers named by the Union in every department of a shop. The committee approves or disapproves the standards submitted to it. In case the standards submitted are rejected either by the committee of the Union or by the employer, the matter is taken up by the representative of the Union and the representative of the Association (of employers). In case of a disagreement it is provided that they two shall select "a third party who shall be a person skilled in the trade." The decision of this third party is final.[2]

Whether in the consent form which it takes where workers' experience has given them confidence in the management, or in a form of organized checks and balances where such confidence is wanting, cooperation and group morale are essential to effective time study. Says the authority from whom we have just quoted, "it is also becoming

[1] Cf. Chapter XXVII, p. 427.

[2] Cooke, Morris L., "Morale as a Factor in Time Study Technique," *Bulletin of the Taylor Society*, Vol. XII, No. 2, April, 1927, p. 332.

more and more evident that time study can play but a comparatively insignificant role where group morale has not been established. And further, if time-study analysis is to be given a recognized place in the evolving industrial régime, it will be largely because in its practice every proper consideration is given to its bearing upon group morale." [1]

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[1] *Ibid.,* p. 337.

CHAPTER VIII

PERSONNEL RESEARCH[1]

THE field for research in personnel activities is almost as inclusive as are those activities themselves. It is not a question of the size of the company, the number of the personnel staff or the variation of its activities consciously designated as "personnel." It is rather a matter of recognizing that from time to time some policy or procedure of the employing organization is bound to affect the conduct or attitude of its employees in a way that necessitates special study. That special study—whether of internal experience, of the experience of other companies or a comparison of the two—is personnel research work.

Obviously much of it is already being done. But explicit recognition of the research function is important as helping to improve its status, its methods and its results. Today such research work is definitely provided for in the personnel staffs of a number of the large companies. But that is not enough. It is further necessary that every executive in large or small organizations, who is charged with the responsibility of administrating all activities identifiable as affected with a personnel interest, should know when research is necessary, what it involves, when good work is being done for him, and what benefits he may expect.

More than that, it is important in the conduct of all phases of personnel work, regardless of the size of the organization, that the operating executives realize that their existing procedures, records and experiences should occasionally be analyzed and evaluated in order that they may continue to produce the best results. Research, properly viewed, should be a continuing activity carried on concomitantly with the direct executive activity in order to assure that policy, procedure and performance are accomplishing what they should.

The Research Point of View. The research point of view in relation to personnel problems fundamentally does not differ at all from that in other fields. This means, of course, that research involves the careful definition of the problem to be studied, the accurate and complete collection of data, the analysis and classification of the data relevant to the statement of a solution or conclusion, the tentative formulation of a solution or conclusion as a working hypothesis, the

[1] By Ordway Tead, Editor of Economic and Business Books, Harper & Brothers; Lecturer in Personnel Administration, Columbia University, New York.

testing of this solution in actual performance to see if it is valid, and the temporary adoption of the conclusion as correct and constituting a sound working basis just so long as the facts and forces on which the conclusions are based remain substantially constant.

This procedure, while it constitutes the agreed scientific approach to any problem, does not in reality tell the whole story about the difficulties and complexities of research activity. There are a number of special qualifying considerations as to research methods in personnel, which should at the outset be recognized and reckoned with by the research worker. In the first place, he must be sure that the terms and definitions he uses are clear and explicit both to him and to the other executives who will make use of his data. Terminology in this field is so new and has thus far been so subject to change that too great emphasis cannot be laid on this point, particularly since the research worker is under the necessity of making his conclusions clear to the operating officials who will utilize them and whose approach to personnel problems may be so unfamiliar with past experience as to be positively naïve. Research workers must appreciate that the general executives are frequently not too careful in the vocabulary which they employ. Words, it must be remembered, are likely to mean different things to different people, depending upon the background of experience of the individual. Fundamentally, it is impossible to use terms correctly if one has not had the experience, personally or vicariously, which the term really represents.

Research workers with a full background of knowledge about a problem cannot expect to translate their experiences and conclusions into the effective thinking of general executives without requiring also that those executives subject themselves to something of the same process of experiencing facts and conclusions which has brought the research worker to the results he has secured. The executive who says "Just tell me your conclusions and then I will make a decision," must be led by the research worker to realize that on this basis the executive has no adequate foundation for a competent decision.

This calls attention to another qualification: that the way in which the research work is done and the form in which the conclusions are stated should be governed closely by the objective of the study. If the research results are to be utilized by the personnel manager, that may call for one type of statement. If they are to be utilized by the president of a corporation with his directors or in a public lecture, that will usually call for a quite different type of presentation. Personnel research as conducted by corporations must almost necessarily be applied research. That is, it looks to the solution of concrete problems confronting management. And the objective of throwing real

light on a new policy and new methods—for relatively uninformed executives—should be kept clearly to the fore when the presentation of results is being considered.

A further qualifying point has to do with the outlook of the research worker himself. Both he and the executive for whom he is working must be aware of the danger that he will see only what he has been taught to look for, only what he wants to see, or fail to see items and meanings which are outside his experience. In short, the training of the researcher, his temperament and his imaginative insight become important factors in his success. What facts he will discover is a highly relative yet very crucial problem. Emphatically, the subject matter of the personnel research worker is not always objective or absolute in quality. He is often concerned with what things mean to other people and how they have reacted to them. He cannot state his problem or his solutions in the absence of this inner knowledge. Hence the necessity for an ability on his part to identify elements and problems which may heretofore have gone unnoticed by those working at them. The inarticulateness of other members of an organization about the inner nature of their problems must not be mistaken by him for the absence of a problem.

It is interesting to see, for example, in a recent study made to identify the items which the rank and file of workers considered important in management policy, that in one particular company the rank and file rated as of little importance the item "security of employment." Upon analysis, the reason for this proved to be that the corporation was a public utility which offered regular employment; and in this case the danger of insecurity and the possible need for security did not occur to the employees as a problem. It was outside the range of their immediate experience.

If, then, these important points regarding the terminology of the inquiry, the necessity for having executives experience something more than bare conclusions, the importance of a clear agreement as to the objectives of the inquiry, and the qualifications of the researcher are kept in mind, it is possible to proceed to a more detailed consideration of the kinds of subjects on which personnel research is usefully being done.

Personnel Research Subjects. There is today reasonable unanimity on the view that the personnel activities of corporations can be conveniently grouped under six major divisions: selection and placement; training; health and safety; job analysis and production standards problems; service work, adjustment and joint relations.

In connection with each of these six divisions, there arise a considerable number of problems upon which research work can from time

to time be usefully instituted. And it will perhaps be possible most graphically to suggest what results can be secured from such research if a brief outline is given of some of the most frequently met and unsolved problems. The controlling thought will be to suggest these difficulties and something regarding the best prevailing methods of attack upon them, rather than to present in detail the scientific processes and methods being employed to reach solutions.

1. *Selection and Placement.* Despite the fact that the personal interview is the prevailing method of reaching a decision as to an applicant's fitness, there has as yet been little research worthy of the name that would look to a standardization of the technique of interviewing, either in terms of questions to be asked or the environmental conditions of the interview.

The direction which most study has taken has been upon tests. The several types of employment tests in use may be grouped as: (1) general intelligence tests; (2) special abilities tests; (3) performance tests, and (4) personality tests.

One of the most fruitful lines of inquiry regarding general intelligence tests is whether it is possible to define the upper and lower limits of the intelligence range demanded at a given job. Preliminary research on this point a few years ago suggested that in the course of time it may be possible to say that the worker who is most likely to be successful and happy at any given job must have an intelligence quotient which lies somewhere between a given high and low. Of course other factors enter in, but other things being equal, this fact of a known standard intelligence range for each occupation may in the light of further study prove to be one valuable index for successful and permanent placement.

Some fruitful results have thus far been obtained from the work of individual psychologists in adapting mechanical tests of one sort or another to the discovery of the special abilities required for a particular job. It is impossible here to go into the technique of constructing special abilities tests. But enough independent work has been done in the field by people like Henry C. Link, Miss Millicent Pond at the Scovill Manufacturing Company, and Mr. Johnson O'Connor at the General Electric Company, to indicate that for many types of work successful results may be obtained by hitting upon some combination of tests which do in action prove to have diagnostic value as to the possession by an applicant of the kind of qualities which best fit him for a given job.

Performance tests, under which may be included the so-called trade tests developed for army use, are also capable of much greater exten-

sion than they have thus far had. At present the first few hours or days on the job are allowed to constitute a performance test for many positions, rather than a definitely controlled test experience which would take place before actual hiring. But for work like stenography and for some of the crafts there is enough experience with performance tests to indicate that there is considerable room for extension of this type of test under intelligent administration, after further study of closely observed experience.

Tests of character, temperamental traits and other personality characteristics have not thus far been applied to industry enough to suggest the research methods which might be employed to encourage their extension. One practical point at which more systematic research would undoubtedly lead to improved results is in the regular following-up of placements by the employment interviewer and the careful compiling of records of the results obtained. This does not mean merely the compilation and analysis of the usual labor-turnover records, important though these are. It means, rather, a fresh attempt on the part of the interviewer to record the various elements in his problem of personal contact and inquiry with a view to seeing which methods of approach and which methods of judgment on his part have yielded best results.

The rating scale is a further testing device, not available for initial selection, but of diagnostic value in helping to place and advance workers whose working qualities and abilities are already familiar to certain executives and working colleagues who might rate them upon specified qualities. There is under way much activity in the use of rating scales; but it is generally agreed that they are in an experimental state and that much careful study is required to bring them to the point of refinement where any existing scale could be widely applied. Several different methods of rating are being tried and a great many qualities are being rated. The great problem is to discover qualities which can be rated with some degree of objectivity and not be wholly matters of opinion in the mind of the rater. The field for careful research on this topic is large and the possibilities of fruitful results seem most promising.

A caution should perhaps be added here regarding the devising and administering of all of the several tests above mentioned. They require for the most part the services of a highly trained psychologist if the research work and the conduct of the tests themselves are both to be competently handled. A full knowledge of the vast amount of previous experiment here, and of the rather elaborate statistical computations required, necessitates that this work be kept away from

novices.[1] Fortunately there is in the Psychological Corporation in New York a responsible professional body which is prepared to advise corporations in this field on a non-profit-making basis with a view to putting them in touch with competent research workers.

Much has been written already about the study of labor-turnover records. It is therefore only necessary here to point out some of the typical shortcomings of American experience with them.

The great danger with labor-turnover figures is that they may not be compiled in such a way as best to diagnose real ills. Gross figures for a company as a whole are likely to mean little. What is wanted is a clear picture of separations and replacements by such groups as the following: departments, types of machines, wage groups, sex, nationality, length of service and age. The research required to procure this information is simple in character. More difficult to obtain is a true picture of causes of leaving from the employees' point of view. Much depends here on the sympathy with which the employee about to leave is received by the employment interviewer who should see all leaving and approve their final pay-checks. But as accurate knowledge as possible of the reason for leaving is a valuable fact, meriting careful research to secure.

The use of gross labor-turnover figures compared from company to company and from place to place appears also to have a certain larger significance. The fact seems to be that, in the aggregate, turnover rises in prosperous times when jobs are easier to obtain and falls in dull times when every one hangs on to his job. So far as this proves to be true in relation to individual companies, it argues, of course, for the adoption of a variety of personnel policies which would make that company an attractive place for workers to remain.

Some phases of the problem which merit increasing concern and study are the following: Is it possible that the objective of low turnover may be pursued to a point where an organization becomes too ingrown, too static, too lacking in the stimulus of new blood and new ideas? Is it possible that in some companies older employees are being released too consistently as a matter of policy, with an ill effect upon the morale of all employees? Is it possible that in some companies a tacit policy of hiring no men workers over forty years of age increases turnover to an unwarranted degree? And conversely, may it not be possible that often a deliberate policy of promotion "up and out"

[1] Bingham, W. V. D., and Freyd, Max, *Procedures in Employment Psychology*, Chicago, A. W. Shaw Company, 1926; Kornhauser, A. W., and Kingsbury, F. A., *Psychological Tests in Business*, Chicago, University of Chicago Press, 1924; Snow, A. J., *Psychology in Business Relations*, Chicago, A. W. Shaw Company, 1925; Laird, D. A., *The Psychology of Selecting Men*, New York, McGraw-Hill Book Company, 1927.

might have a stimulating effect upon the whole organization? All of these are matters requiring serious research—questions on which much light still needs to be thrown and much information needs to be carefully accumulated.

If it is thus borne in mind that research work is fundamentally not only an inquiry into new lines of activity but a critical scrutiny of experience which has already taken place, its vital place in every organization's scheme will be more fully appreciated. And it will also more readily appear that research work should not be done solely by segregated and specified individuals. It should also be an occasional part-time activity of executives, responsible for the conduct of particular functions like selection and training, critically and impartially to survey their own work.

2. *Training.* The fact that successful corporate training activities entail careful prior and consecutive research is only just being recognized in any general way. The subjects on which this research is required are such items as objectives, content, methods of instruction and results.

Just what objectives are to be held in view is a more complex question than might at first appear. To what groups is training to be given? Is it only narrow job instruction, or is there also the purpose of "upgrading," or training for advancement? Are the objectives of building company spirit, understanding of company policies, training in leadership, training in health, safety, citizenship, group action and in executive capacity also to figure in the training program? Since the tendency in company training is markedly along these broader lines, the relevance of this problem of objectives should be realized. And examination of a given training program frequently reveals that there never has been an explicit statement as to what results the effort is designed to yield.

The content of training should, of course, be determined only after objectives have been adopted.[1] Job training requires a radically different content from morale training. Junior executive training obviously needs a content quite unlike that necessary for a program of new manual employee instruction. And the building up of the content for all programs should be undertaken from the definitely research point of view of finding the key problems in each field, reducing them to their elements, discovering those of simplest pedagogical difficulty, and then building up a curriculum of progressively increasing complexity and inclusiveness. For a training director to build up courses

[1] Strong, E. K., and Uhrbrock, R. S., *Job Analysis and the Curriculum*, Baltimore, The Williams & Wilkins Company, 1923; Greene, J. H., *Organized Training in Business*, New York, Harper & Brothers, 1928, Chapter III.

without close knowledge of the specific problems and needs of his organization would be sheer waste of valuable time.

Unless the trainer sees his problem in relation to the right conception of the true nature of the learning process, his results will obviously be insignificant. So much that passes for educational work even in industry is really verbal glibness that it is important to re-emphasize the fact that true learning is the acquiring of an ability to act, to feel, to reflect. And the research into content as well as into teaching methods which forgets this point is sure to go wide of the mark.

Research into teaching methods is a tremendously vital phase of the whole problem. We know today that several methods are available. A teacher may use recitations, cases, projects, demonstrations, lectures, problems, conferences or a combination of these. But it has become obvious that one or another method is better or worse for a given kind of teaching problem. Naturally one does not lecture at a loom to a learner who is trying to acquire the mental and muscular coordination which makes a good weaver. It is easy here to see that the learner must himself make his own nervous and cortical sets which alone are the means of his acquiring a skill. It is not so easy to see that employees in a shop committee learn a sense of responsibility and a capacity for reaching sound decisions only by having to assume responsibility and make decisions. Research into training methods must eventually bring to the entire executive group a realization that every training objective necessitates a conscious use of one or more methods of training which will assure that learners themselves go through the experiences which it is intended that they shall master and assimilate, and in the exercise of which they are expected to develop skill.

The aspect of training research as yet almost in its infancy relates to the measuring of results. A certain few companies have kept records of job instruction which show conclusively how much the training period has been shortened; how much this has added to production per worker, both at the outset and in enabling the new worker to attain a new high level of proficiency; how much wastage is entailed; how much overhead cost is required. In short, certain valuable results can be reduced to a dollars and cents basis with a little careful study. But with respect to other types of training, as, for example, executive training conferences, the measure of results may be far harder to state. One aspect of costs which is important in this connection can be; namely, the rate of turnover among junior executives or apprentices to executive positions, who never reach, or do not hold for long, the executive jobs they are supposed to fill after training. Sometimes this is due to a too conservative policy of advance-

ment of such juniors or to a too low-salary scale; all of which enables other companies to profit from such training. Certainly enough of such shifting about comes to warrant further study of the problem.

This whole difficult question of the measuring of educational results leads in its broader aspects into the question of the measurement of morale. This means a measurement of employee attitudes, desires, interests and loyalties. Here we approach an all but virgin field for research. Such study as has been made of the measurement of attitudes [1] has not as yet been applied at all to specifically industrial groups and issues. More immediately relevant is the methodology now being experimented with by Mr. J. David Houser and described all too briefly in his book, *What the Employer Thinks.* This method entails a personal canvassing of employees, in which they are asked to answer a number of questions as to their opinions of their company's personnel policies and results. As far as can now be judged, it would seem that fruitful results can probably be obtained from such rating efforts if scientifically and conscientiously compiled and interpreted. Certainly present indications are that such a sounding out of employee sentiment does disclose in an indicative way important points of strength and weakness in a company's efforts to obtain good morale.

Once the idea prevails that all the experience of each individual within the organization can have educational value, the ramifications of the field of training interest and research will be realized; and study will be broadened accordingly. This applies, for example, with great force to all types of deliberative conference which now take place. Many organizations now have group meetings, both regular and occasional, of staff executives, line department executives, foremen, salesmen, intradepartmental staff groups, safety committees, employee representation plans, mutual benefit societies, and so on. Recent studies of the technique of group conference show beyond question that with proper study and administration the process of group deliberation and action can be one of notable educational value to all participants. Two things are needed: the training motive must be made consciously to animate all such gatherings; and the methods of conducting a conference which make it most fully an educational medium must be clearly in the mind of the chairman at least, and if possible the entire group should be cognizant of these methods.[2]

One further point in training research is consideration of the application of all the other training devices beyond the more usual educa-

[1] For example, by Professor L. L. Thurstone at the University of Chicago.

[2] Elliott, Harrison S., *The Process of Group Thinking,* New York, Association Press, 1928; Sheffield, Alfred E., *Joining in Public Discussion,* New York, George H. Doran Company, 1922. (Workers' Bookshelf No. 1.)

tional methods. Visits to other companies, visits through the entire plant, industrial museum exhibits, motion pictures, company house organs, etc., at once suggest themselves as media of stimulation and enlightenment which could be much more freely adapted than is now usually the case. Indeed, once a company comes to grasp in a vivid way wherein the learning process of individuals lies, it will be able to make use of a great variety of agencies and methods not now employed. Think, for example, of the possible uses of the radio, the phonograph, of more artistic work surroundings, of company libraries, of incentives to home study, of scholarships, of loans for travel purposes, and the like. Given a broad enough objective for the company training program, a world of methods opens up for study and application.

3. *Health and Safety.* Confining the discussion first to health problems, it is obvious that a variety of research interests arises. Perhaps first in importance is the determination of health standards to be required of those at each class of work in a company. To get the best results, as with many specialized and partly technical problems of personnel research, these cannot be handled solely by the specialist. The employment manager and the production executive should join with the medical adviser in determining such standards as age, sex, weight, height, strength, reach, eye and ear acuity, which would be required for each position. Several considerations have to be weighed here. This question ramifies not only into production issues, but into matters relating to any benefit plan, such as group-insurance provisions, pension provisions, state compensation laws and special occupational disease hazards.

The standards adopted bear closely on the kind of physical examination to be given to entrants into company employ. The whole question of the basis for rejection requires separate study in each corporation. And this in turn hinges upon the amount of clinical, corrective and preventive health work which it is the company's policy to undertake and maintain.

The extent to which periodic re-examination is warranted deserves more study than it usually receives. The discovery and elimination of peculiar hazards to health in each plant is a special and important element in this branch of research. It may be drinking water, washing methods, factory or store housekeeping methods, dust hazards, chemical hazards, excessive humidity, weather exposure, high temperature at the work place. These and many other items may create an environment which predisposes to illness or disease, requiring the most careful investigation and research by experts.

The sources and causes of contagion and infection have to be

studied. Not only will the acute afflictions like tuberculosis and venereal disease have to be scrutinized, but the spread of the common cold is a subject meriting far greater research attention in industry than it now receives. The evidence seems to be that illness growing out of colds causes more absence and general debility than that from all other sources put together. Yet research here has scarcely scratched the surface of the field.

In fact, the intensive study of company medical records from an analytical point of view is neglected far more than it should be. There is undoubtedly in industry as a whole a wealth of research material which could be of great assistance for future preventive work, if its study were more systematically pursued. That valuable group of activities covered by the phrase "preventive medicine" has really been applied but little in industry as a whole. And the methods of popularizing wholesome ideas about diet, personal habits, treatment of colds and constipation, need much more research to put what is known about keeping well into a form to be influential in the lives of millions.

Speaking more generally, the problem of health work in the small plant, of the relations of the company doctor to the local community doctors, of applicants who are rejected by one company after another, of the kind of work adapted to the physically handicapped and mentally subnormal, and to men and women over forty-five years of age—these all require a great deal of study. And they require also to be brought increasingly to the attention of those owners and high executives who have a sufficiently broad social vision to be willing to lend a hand to their solution.

The problem of the causes, incidence, costs and remedies of accidents in industry has perhaps received more sustained and thorough analysis than many other personnel topics. Undoubtedly the wide spread of state workmen's compensation legislation has helped to force research upon this problem. Certain it is that there are far less crucial and new difficulties in this field to which attention can be called.

It is true, however, that our understanding of the inner nature of the problem is shifting from the consideration of mechanical hazards to the examination of employee states of mind. Apparently protective devices in their greatest efficiency will not eliminate all accidents, either serious or slight. The attitude of the employee, his fatigue, the amount of illumination, his attentiveness and alertness, the extent of non-industrial worries, preoccupations, or mental abnormalities, all have much to do with accident susceptibility. And on this psychological side little helpful research has as yet been instituted. How distracting states of mind can be identified or forestalled; when fatigue has reached

a danger point; perhaps what mental types of people are more predisposed to accidents than others, are kinds of questions for which the answer has still to be sought.[1]

In general, also, accident records if properly compiled afford a source of research study which should be most suggestive; both within one company and when assembled by larger groupings of industry and locality. To determine the real cause of any given accident may be a far less simple matter than appears on the surface. Whether an accident is due fundamentally to supervisory, mechanical or employee shortcomings; to what extent it is due to the worker being newly employed; to what extent the foreman is indirectly or directly to blame; these are questions to be carefully studied.

4. *Job Analysis Problems.* The technical methods of job analysis with particular reference to time and motion study, the improvement of production methods and the setting of production standards are considered elsewhere in this volume. But consideration of the relation of job analysis activity and of production standards data to the operation of the personnel policy is within our province. For the line of activity representated by the phrases "job classification," "job rating" and "wage groupings" entails certain uses of job analysis data which are increasingly being made by the personnel department. These uses imply careful research work from the personnel point of view.

The problem is to bring out of the typical confusion of job names and classes and chaotic wage rates, a structure of consistent job names, and then job classes, which can be grouped together in an ascending scale, for the purposes of tying each job up within a wage rate which pays what that job is worth relatively to the difficulty of other work in the organization.[2] It is sufficient here to point out that executives working from the personnel point of view should study the job analyses of all the jobs in the organization, to be sure that in grading jobs in relation to pay such factors as the following are being given adequate weight: necessary amount of prior education and training; available labor supply for the kind of work; special occupational hazards entailed; local costs of living; wage scales of other plants competing in the same labor market. These and other considerations affected with a personnel interest definitely require light which only personnel research can supply. And job and wage classifications which ignore these factors will be woefully deficient in accuracy and workability.

Similarly, when it comes to setting piece rates or to instituting

[1] Anderson, V. V., *Psychiatry in Industry,* New York, Harper & Brothers, 1929, Chapter IX.

[2] Lott, Merill E., *Wage Scales and Job Evaluation,* New York, The Ronald Press Company, 1926.

production standards (of amounts of work to be done per worker at a job per hour, day or week), the personnel interest arises and entails special study from its point of view. Concretely this means that amounts of expected output must be set in relation to fatigue factors, possible advisability of rest periods, minimum and maximum amounts of pay at each job which it is decided each should yield, compensation for the time when machinery is being repaired or no materials are available, allowance when new machines or designs are being introduced, or other changes occurring in the process.

Data on all such questions are often available, both out of current experience with production standards already installed and from past production records. To interpret them correctly and apply them to new problems and conditions is a problem of no small proportions. And experience seems to show that *no executive who is not well trained in the personnel point of view or actually a member of the personnel staff is able to evaluate and apply all such factors in the way they merit when the adoption of production standards is taking place.*

For it is as yet all too inadequately realized among those who approach this problem from an engineering or production point of view that the difficulties surrounding the actual adoption of production standards and standardized working methods may well be almost as acute as those surrounding their discovery. What workers think and feel about the utilization of such data in determining the amounts of work that they shall do and the wages they shall be paid, affect the total working situation in a vital way, and a conscientious study of this aspect of the problem is a responsibility of personnel executives which has an appreciable research angle to it.

There has recently been a great advance in the technique of both time and motion study, and the research here from a production standpoint has yielded remarkable results. But there still is room for study as to how such results are to be applied by groups of individual workers in a way that will assure their improved training, their good-will and their loyal adherence to standards and methods discovered to be best.

5. *Service Work.* Under the caption "service work" is usually grouped that miscellaneous group of activities which relate less directly to production activities but which do have a potent influence on employee attitudes. This would include such matters as the administration of plans for accident and disability compensation, sickness compensation, old age and death benefits, and unemployment benefits. It would also include recreational activities of all sorts and the operation of such facilities as company restaurants, cafeterias and rest rooms, and athletics, recreational and educational programs.

It is obvious that each and all of these multifarious activities may

from time to time require much intensive special study to assure their proper operation and to enable executives to reach a decision as to whether or not any one or another of them should be introduced or withdrawn. Problems of sickness, old age, death and unemployment benefits are peculiarly in need of research before anything of a constructive nature is done. Each of these matters entails actuarial studies which must necessarily be undertaken by specialists, and enough experience in these activities is available today to make it clear that a company may embark upon a plan involving serious inroads upon its income only after competent actuarial advice is obtained.

In the same way, in connection with the administration of food-serving activities, such problems as cost, food values and serving methods arise which should entail a study of previous experience.

In respect to those social activities which the individual might expect to find in his neighborhood or community setting, the activities of a corporation must be carefully studied in order to avoid duplication of efforts and in order to see that the corporation does not become the sole institution about which the individual employee's recreational life revolves. Study of the real relationship between a corporation and all of the community facilities upon which it may or does draw is a most important part of its program of cultivating community goodwill. This will be true in relation to educational facilities, recreational activities, health measures, housing facilities and similar civic responsibilities upon which a company should embark, if at all, only after the most thorough study to be sure that there is no alternative method by means of which necessary facilities may be provided.

6. *Methods of Negotiation and Adjustment.* Under this caption may be grouped all those individual and collective efforts which have to do with the determination of the terms of the labor contract, including agreement upon hours of work, wages, vacations, holidays, special reasons for discharge, disciplinary measures, absences, grievances and complaints.

It will at once be seen that these matters entail research into a number of different and significant fields. The personnel department, for example, is usually the agency which examines into costs of living and family budgets. There would also be required some study to see just what disciplinary rules should be adopted and how they should be enforced in terms of fines and rewards. The application of wage scales to the pay rate of individual workers presents peculiar problems of individual rating evaluation which definitely require a personnel approach and special analysis. There is also the problem of what should be the agency for negotiation and adjustment as between the corporation and its employees. With recent developments in the use of em-

ployee shop-committee plans for such negotiation there has opened up a considerable field of study from which both the company already using a plan and a company contemplating the inception of this type of plan can benefit.[1]

If a company contemplates or has in operation any more elaborate payment plan than the usual week work or piece work, including such devices as elaborate individual-incentive-payment plans, group-payment systems, annual bonuses, profit-sharing or stock-purchasing plans, these in their several ways present problems of policy demanding both preliminary analysis and constant study during operation. The experience with these special payment methods is now so extensive that research into the results already obtained is essential to any company which would not repeat needless mistakes.

7. *The Labor Audit as Personnel Research.*[2] Important developments have been made in providing check lists for a systematic survey of all the personnel activities of companies either by the personnel manager himself or by some one from outside. The aim is to provide the observer and reporter with a list of topics and questions which will cover comprehensively the points which should be studied in the effort to evaluate the success of the going labor policy. While the primary purpose of such audits is an inspection of labor policy and its results, they obviously also yield data for research. Different approaches to such an outline of a complete labor audit, or personnel survey, or analysis of personnel activities, as it is variously called, have been made by a number of specialists. The unpublished work of the Industrial Relations Counselors, Incorporated, of New York should be mentioned here.[3]

In conclusion, it will be seen that in a relatively new field like personnel management, where a great variety of experiments is going forward, the need for research and evaluation of experience is peculiarly acute. There is some data more or less extensive upon almost all personnel plans that a company might decide to adopt. To institute preliminary research into the results of such trials is a counsel of prudence. And to learn from one's own experience by the careful analysis of successes and failures is equally a sign of good management. Both tasks impose upon some thoughtful executive in every organization responsibility for encouraging, initiating and profiting from research into such personnel problems as those above suggested.

[1] Burton, E. R., *Employee Representation,* Baltimore, The Williams & Wilkins Company, 1926.

[2] Cf. Chapter XXV.

[3] See also Tead, Ordway, and Metcalf, H. C., *Personnel Administration,* New York, McGraw-Hill Book Company, 1926, Chapters XX and XXI; and *Personnel Research in Department Stores,* Pittsburgh, Research Bureau of Retail Training, 1927.

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PART III

MANAGEMENT STANDARDS

Each institution has brought with its development demands, expectations, rules, standards. These are not mere embellishments of the forces which produced them, idle decorations of the scene. They are additional forces. They reconstruct. They open new avenues of endeavor and impose new labors. In short, they are civilization, culture, morality . . . if one is going to live one must live a life of which these things form the substance. The only question having sense which can be asked is *how* we are going to use and be used by these things, not whether we are going to use them.—JOHN DEWEY.

Why is it not universally recognized that an end is a device of intelligence in guiding action, instrumental to freeing and harmonizing troubled and divided tendencies? . . . Ends are foreseen consequences which arise in the course of activity and which are employed to give activity added meaning and to direct its further course. . . . They are the ways of defining and deepening the meaning of activity. Having an end or aim is thus a characteristic of *present* activity. It is the means by which an activity becomes adapted when otherwise it would be blind and disorderly, or by which it gets meaning when otherwise it would be mechanical. In a strict sense an end-in-view is a *means* to present action; present action is not a means to a remote end. Men don't shoot because targets exist, but they set up targets in order that throwing and shooting may be more effective and significant.—JOHN DEWEY.

CHAPTER IX

CLASSIFICATION AND SYMBOLIZATION[1]

Less than fifty years ago John Fritz, ironmaster and holder of the Bessemer medal, produced designs for steam engines by drawing with his cane in the sand on the foundry floor. When parts so designed were finished and assembled he is quoted as saying, "Now start her up and we will see why she does not work." Trial and error with a vengeance! But that day is gone. Behold nowadays the construction of a 200,000 HP steam turbine with no guesswork in any part of it. Everything is designed and completely predetermined. In fact, were any part not so predetermined it is almost certain that it would be done wastefully. Lack of economy in time and materials is the essence of the "cut and try" method.

But before there can be design and predetermination there must be developed a standard terminology, a language capable of describing just what is to be done and the way of doing it, somewhat as an architect's drawings, with their symbols for such things as wood, iron, steel, stone, steam pipes and electric wires, outline the house that is to be built. In the development of such a language for industrial classification recognition of the various classes and kinds of "things," material as well as immaterial, which constitute the industrial process, is almost the first step.

Only as we learn to classify, and as a result of such classification to eliminate, to simplify, to standardize and to codify, does any genuine science of management emerge. And then the moment one begins to classify, there appears the necessity for an accurate and definite terminology based on the classifications adopted—as with the natural sciences: for instance, with botany, zoology and chemistry. To obtain greater precision in our nomenclature and to economize time it has been found expedient to substitute the briefest possible symbols for all terms used repetitively in the process of manufacture. From the very start classification and symbolization must proceed hand in hand —practically simultaneously.

Hardly a generation ago it was quite customary in industry to emphasize differences rather than to look for similarities. Shoe manufacturing was held to have nothing in common with the making of books. Even two machine shops, the one manufacturing machine tools

[1] By Morris Llewellyn Cooke, Consulting Engineer, Philadelphia; Past President of the Taylor Society.

and the other making repairs on steam locomotives, were looked upon in many quarters as so wholly dissimilar as to make the experience of the one of negligible value to the other. Or carrying the same thought a step farther, two different shoes, or two different books, or two different suits of clothes, manufactured in the same establishments under virtually identical processes, were rarely viewed from the standpoint of their similarities, largely because they did not look alike and because classification had not been established as the proper route to effective control in the management of their fabrication. It is only through the emphasis on similarities, and through the doing away with non-essential differences, that classification becomes possible.

One of the first lessons to be learned in any effort to classify is to distinguish between numbers of things and kinds of things. Classification is not interested in quantities, only in varieties. Large-scale enterprises have as a rule not profited as much relatively from classification and its consequent symbolization as have smaller concerns, for the reason that size has been looked upon as a deterrent, when as a matter of fact it has almost nothing to do with the problem.

The Drafting of Classifications. The most comprehensive, well-balanced and permanent system of classification for an industrial enterprise will be one which is the result both of an analysis of the undertaking as a whole and of a gradual synthesis, or building up out of smaller and more detailed classifications, where each of the latter is the result of detached studies of individual parts. It is advisable that these two kinds of classification be carried on simultaneously and from the start.

Before a system of classification with its appropriate symbolization is put into general use it should be thoroughly tried out, but in some more or less isolated part of the work. After the system as a whole has been finally decided upon and put into use changes, except those involving simple additions or subtractions, should be made only after the fullest consideration. In fact, even adding items to a group or subtracting them from a group should be done with the utmost care, and only after following a carefully prescribed routine. Taylor had one invariable rule by which he tested all suggestions as to change: has the suggested change been given at least as much thought as was used in adopting the original standard?

It must be remembered that, as here applied, classification and symbolization represent a radical departure from existing practices, and it becomes possible not only to name every element in an undertaking, whether of function, or personnel, or of material, but to designate it with a symbol and also to locate with a symbol the matter so described. Until the employees of an establishment have become thoroughly accus-

tomed to the use of symbols and have learned to appreciate their significance in the whole system of management, it is necessary to use the utmost care in seeing that changes are not too easily and too frequently made.

With the system of classification and symbols fully determined upon, it becomes possible to begin the final grouping of the various items which in their sum total constitute an industrial undertaking. It must be remembered that classification begins where symbolization begins. Without something to classify and hence to symbolize, no general symbolization scheme can be developed. But it is only after this scheme has been pretty fully planned that it is possible to build up complete classifications. The forces and material at the command of an industrial organization must be marshalled in orderly array before they can either be used effectively as they stand or studied with an eye to their improvement. This orderly arrangement of parts is that classification which, as has been said, lies at the very bottom of any proper system of management.

A Typical Example. Our present-day conception of an industrial enterprise is that it is composed essentially of a definite number of elements that have been subjected to intensive study, such as buildings, machines, personnel, operations, and so on, all of which can be definitely classified. Each and every item in each classification can be systematically listed under its appropriate schedule and defined with as much exactitude as may at any time be thought desirable. We are certainly moving in the direction of a maximum of definition and predetermination of elements.

Such an attitude represents a fundamental change in outlook from the time, not many years back, when any such itemization would have been considered as impossible as it would have been useless. Large-scale enterprise, long-time planning, the economies of simplification and standardization, and a growing appreciation of the value of time in the industrial process, all put a premium on definition—in some parts of the field a definition which tends toward scientific precision.

On Figure 4 are grouped sample pages from a tool classification in which are listed every "implement" which could conceivably be utilized in the work of a particular plant. The term "implement" is used to emphasize the fact that there are included under it many items which have not ordinarily been looked upon as tools, such as blocks of wood and bolts—both in varying sizes—used in setting up work in machine tools. As late as the apprentice days of the present writer but a very small part of the equipment listed on this tool classification was kept in the tool room or in any recognized location. At a time when cutting tools were shaped by hand, sometimes on a foot-driven grind-

BASE SHEET		HAMMER GROUP [H]		CHISELS [HC]		CAPE CHISELS [HCC]	
TA	ABRADING—Tools Used for Rubbing, Scraping, Filing, Grinding, Shearing, Punching, Breaking, etc.	THA		THCA		THCCA	
TB	BENDING—Tools for Producing Changes in Shape, Such as Bending, Folding, Spinning, etc.	THB	BARS FOR CHIPPING	THCB		THCCB	
TC	CLAMPS—And Holding Devices of All Kinds Including Bolts and Screws.	THC	CHISELS*	THCC	CAPE*	THCCC	
TD	DRILLING—Tools That Remove Metal from the Interior Such as Drills, Boring Bars, Cutters, etc.	THD	DIES, STAMPS, ETC.	THCD	DIAMOND POINT	THCCD	
TE	EDGE—Tools for Working Wood and Tools for Working Plastic Materials, Such as Clay, Sand, Putty.	THE		THCE		THCCE	
TF		THF	FLATTERS, FULLERS, ETC.	THCF	FLAT	THCCF	
TG	HEATING—Tools Used for Heating, Lighting, Melting, Moulding, Tempering, Annealing, Drying, Cooking, etc.	THG	GOUGES	THCG	GOUGE	THCCG	
TH	HAMMERS—*Tools That Work by Striking or by Being Struck, Sledges, Tups, etc., Chisels, Flatters, etc.	THH	HAMMERS, SLEDGES	THCH		THCCH	
TJ		THJ		THCJ		THCCJ	
TK		THK		THCK	CAULKING	THCCK	
TL	MILLING—Tools for Milling or Sawing Metal.	THL		THCL		THCCL	EXTRA LONG
TM	MEASURING—Instruments of Precision, Weights, Measures, Gauges, etc., Electrical Instruments.	THM	MALLETS, MAULS, ETC.	THCM		THCCM	
TN	PRINTING—Tools for Covering Surface with an Adhesive Foreign Material and for Removing Same.	THN	PNEUMATIC HAMMERS, ETC.	THCN		THCCN	
TP	PARING—Tools That Remove Metal from the Surface by Cutting, Except Slotters and Milling Tools.	THP	PICKS, MATTOCKS, ETC.	THCP		THCCP	
TR	TRANSPORTATION—Tools Used in Moving Materials from One Place to Another; Buckets, Wheelbarrows, Brooms.	THR	DRIFTS	THCR		THCCR	
TS	SLICING—All Parting Tools and Slotter Tools.	THS		THCS	SIDE	THCCS	STANDARD LENGTH
TT	TEMPLETS—And Instruments for Duplicating Work, Including Jigs and Fixtures.	THT	TUPS, RAMS, ETC.	THCT		THCCT	
TU		THU		THCU		THCCU	
TV		THV		THCV		THCCV	
TW	WRENCHES—And All Tools Used for Causing Rotation.	THW		THCW		THCCW	
TX		THX		THCX		THCCX	
TY		THY		THCY		THCCY	
TZ	MISCELLANEOUS—Tools Not Otherwise Classified.	THZ		THCZ		THCCZ	

*Asterisks show line of subdivision.

FIG. 4. ILLUSTRATIVE SECTIONS OF A TOOL CLASSIFICATION

stone, to the fancy of each machinist using them, there was missing the incentive we now have for classifying tools manufactured from steels alloyed to meet special purposes and shaped with mathematical precision for the most effective performance of special tasks.

In this classification "HCCS" is the mnemonic symbol for a standard length cape chisel, one belonging to the H or "hammer group" of implements in the tool room, which group is described in the classification as those that "work by striking or by being struck." The H or "hammer group" includes sledges, tups, chisels, flatters, etc. It will be noticed that the letter with the largest significance (H), as denoting the "hammer group," is placed on the extreme left. The letter to the immediate right of this (C), as denoting the "chisel class," has a lower significance. And the letter still farther to the right (C), as denoting the kind ("cape") of chisel, has a still lower significance. Of course this procedure can be carried on as far as may be necessary. The size of the chisel is indicated by a figure placed immediately following the initial letter.

The major classifications in the great majority of enterprises, in addition to that for tools, will generally be limited to the following: employees; machines and work places; plant and fixtures; charge accounts; stores; worked material (a name assigned to stores upon which work has been done) and its resulting product; instructions, which are sometimes called standing orders; and customers and markets. Before discussing further specific classifications, it will make for clarity to comment upon the design and use of symbols without which classifications would have a limited usefulness.

Letters versus Numbers in Symbols. The symbols adopted to identify the individual items in the several classifications may be composed (1) of numbers or (2) of letters, or rather of combinations of letters and numbers. The time has hardly arrived when any final decision is possible as to the relative utility of these two systems. Taylor strongly advocated the use of lettered symbols. In fact, he held that it was virtually impossible to develop the precise understanding required by scientific management in a plant or an industry except with the aid of mnemonic symbols—those assisting the memory. Lettered symbols were used in all cases of scientific management developed directly by him or under his guidance.

Nevertheless it must be recognized that symbols expressed in numbers are the general rule in industry. One outstanding reason for this is that modern tabulating machines have been developed with a minimum of regard for lettered symbols. Such machines have, of course, been used with mnemonic symbols simply by translating letters into numbers when the symbols being used require this adaptation. If

ACCOUNTS FOR SMALL CARRIERS CLASS II	ACCOUNTS FOR SMALL CARRIERS CLASS III	ACCOUNTS FOR LARGE CARRIERS CLASS I
IV. TRANSPORTATION—RAIL LINE:	IV. TRANSPORTATION:	IV. TRANSPORTATION:
1261. Superintendence and dispatching.	2241. Superintendence and dispatching.	371. Superintendence.
		372. Dispatching trains.
		373. Station employees
1262. Station service.	2242. Station service.	374. Weighing, inspection and demurrage bureaus.
		375. Coal and ore wharves.
		376. Station supplies and expenses.
1263. Yard enginemen and motormen.		377. Yardmasters and yard clerks.
	2243. Yard employees.	378. Yard conductors and brakemen.
		379. Yard switch and signal tenders.
		380. Yard enginemen.
1264. Other yard employees.		381. Yard motormen.
	2244. Fuel for yard locomotives.	382. Fuel for yard locomotives
1265. Fuel for yard locomotives.		383. Yard switching power produced.
1266. Power for yard locomotives.		384. Yard switching power purchased.
		385. Water for yard locomotives.
	2245. Miscellaneous yard expenses.	386. Lubricants for yard locomotives.
		387. Other supplies for yard locomotives.
1267. Other yard expenses.		388. Enginehouse expenses—Yard.
		389. Yard supplies and expenses.
1268. Operating joint yards and terminals—Dr.	2246. Operating joint yards and terminals—Dr.	390. Operating joint yards and terminals—Dr.
1269. Operating joint yards and terminals—Cr.	2247. Operating joint yards and terminals—Cr.	391. Operating joint yards and terminals—Cr.
		392. Train enginemen.
1270. Train enginemen and motormen.	2248. Train employees.	393. Train motormen.
		401. Trainmen.
1271. Fuel for train locomotives.	2249. Fuel for train locomotives.	394. Fuel for train locomotives.
1272. Power for train locomotives.		395. Train power produced.
		396. Train power purchased.
		397. Water for train locomotives.
		398. Lubricants for train locomotives.
1273. Other train locomotive supplies and expenses.	2250. Other train expenses.	399. Other supplies for train locomotives.
1274. Trainmen.		400. Enginehouse expenses—Train.
1275. Train supplies and expenses.		402. Train supplies and expenses.
		403. Operating sleeping cars.
1276. Injuries to persons.	2251. Injuries to persons.	420. Injuries to persons.
		418. Loss and damage—Freight.
1277. Loss and damage.	2252. Loss and damage.	419. Loss and damage—Baggage.
		414. Insurance.
		415. Clearing wrecks.
1278. Other casualty expenses.	2253. Other casualty expenses.	416. Damage to property.
		417. Damage to live stock on right of way.

FIG. 5. EXAMPLE OF CLASSIFICATION OF ACCOUNTS FOR STEAM RAILROADS BY THE INTERSTATE COMMERCE COMMISSION

with the further development of industrial techniques the utility of mnemonic symbols becomes better understood and they come into more general use, adequate tabulating devices undoubtedly will follow. In Taylor's day only the earliest and simplest types of these machines were available. His greatest work was done in a period when practically all entries on office and shop records were made by hand. His advocacy of lettered symbols was based largely on their memory value.

In addition to the memory-aiding quality of lettered symbols it must be recalled that they make possible a much larger number of combinations possessing a given number of characters. For instance, the ten numerical digits permit 999 combinations of three digits each, while the twenty-three letters (as explained later, I, O and Q are not available) permit 12,167 combinations of three letters each. On occasion the general utility of mnemonic symbols has been enhanced by adding characters, as from the Greek, to the English alphabet. It is believed that the use of lettered or mnemonic symbols will become more general in industry as the need for a more scientific and meaningful—one is tempted to say philosophical—system of industrial nomenclature becomes generally recognized.

Numbers as ordinarily used for symbols in connection with industrial classifications are without significance except as a tag for identification. For instance, in the classification of accounts provided for the steam railroads by the Interstate Commerce Commission (Figure 5), each account has a number which is wholly arbitrary and meaningless except for the fact that it is one of a series. The Dewey decimal system of symbols, composed principally of figures, is used in connection with library book classification and for indexing certain classes of scientific data. Here, however, so far as is possible the same figure is used to designate the same word when used in thousands of different combinations. For instance the symbol for any book on natural science in the Dewey classification will begin with 5. (See typical section, Figure 6.) Again in the Dewey system some significance attaches to the distance of the several figures composing the symbol from the left or right of the decimal point. In a Dewey system index of data on the human nervous system one set of German cards utilizes three places to the left of the decimal point and five or six to the right. The Dewey system represents a real effort toward making numerical symbols also mnemonic in character.[1]

But as symbols composed of letters can be made so much more

[1] Carl G. Barth is my authority for the statement that the enormous numbers of charge accounts (The Book of Accounts) of the Pullman Car Works were designated by numbers so arranged as to be largely mnemonic, along the lines of the Dewey system.

mnemonic than those made with figures, further discussion will be confined to symbols made with letters.

In improperly constructed systems, a combination of letters, even though the base always remains the same, may give a symbol with as

000 GENERAL WORKS
100 PHILOSOPHY
200 RELIGION
300 SOCIOLOGY
400 PHILOLOGY
500 NATURAL SCIENCE
600 USEFUL ARTS
- 610 Medicine
- 620 Engineering
  - 621 Mechanical Engineering
  - 622 Mining Engineering
  - 623 Military and Naval Engineering
  - 624 Bridges and Roofs
    - 624.1 Piers, Foundations, etc.
    - 624.2 Girders, Stresses and Strains
    - 624.3 Trussed Bridges
    - 624.4 Tubular Bridges
    - 624.5 Suspension Bridges
    - 624.6 Arched Bridges
    - 624.7 Compound Structures
    - 624.8 Movable Bridges
    - 624.9 Roofs
  - 625 Railroad and Road Engineering
  - 626 Canal Engineering
  - 627 River, Harbor and General Hydraulic Engineering
  - 628 Sanitary Engineering
  - 629 Other Branches
- 630 Agriculture
- 640 Domestic Economy
- 650 Communication
- 660 Chemical Technology
- 670 Manufactures
- 680 Mechanic Trades
- 690 Building

700 FINE ARTS
800 LITERATURE
900 HISTORY

Fig. 6. Example from the Dewey Library Classification

little mnemonic significance as the combination of a like number of numerals. Thus the sales department may always be known as department A, the purchasing department as department B, and so on. This simply means that every one using the system will have to memorize not only the base letters but all their subdivisions. In a business of

any size this is so difficult as to render the application of such symbolization in any large way practically impossible.

Construction of a Mnemonic Symbolization. In lettered symbols the mnemonic quality is usually accomplished by using the initial letter of the word which it is intended to represent. The letters are used very largely as figures are used in the Dewey decimal system; that is, they have a place value, dependent somewhat upon their position with regard to the other letters in the combination in which they are used. Figures are used in combination with letters, but they are only mnemonic when they have a descriptive quality. The memory is not assisted by representing a form or an operation or a machine by such an arbitrary figure as 24, either alone or in combination with several letters, unless this figure represents a quality of or use for the thing so symbolized. It does, however, add to the mnemonic quality of the symbol to use 24 in any combination of letters and figures describing a rule twenty-four inches long or the twenty-fourth machine in a given row. In the Taylor stores classification a symbol for a final individual article always has a number preceding the last letter, which number is often without descriptive quality.[1] The same is true of the symbol assigned to every part in each of the ultimate subassemblies of a composite piece of worked material.

It is no better to use a letter unless it has a descriptive quality than it is to use a figure without such a quality. In every case the effort must be to give the letter chosen as large mnemonic significance as possible; that is, it must tend as much as possible to call to the mind the object or function referred to. It must be admitted that only too often it cannot be made to do this except by association or "brute memory." It is taken for granted that the person seeking to interpret a symbol is familiar with the general rules upon which the system is based. However, it is not always necessary that one should be able to interpret a symbol in order to use it. Hundreds of workmen use symbols every day without the slightest idea as to their significance. To quote a colloquial expression used by James Mapes Dodge, to illustrate the truth of this very matter, "One does not have to know French to use plaster of Paris."

In using the alphabet for the purpose of constructing mnemonic symbols, the letters I and O are not used on account of the danger of confusing them with the figures representing one and zero. For the reason that Q has rarely any mnemonic significance (*i.e.*, because very few words begin with or contain Q) and also on account of the likelihood of confusing it with the figure representing zero (0), when the

[1] See Figure 9, p. 125.

S — CLASSIFIED STORES	
S A	
S B	
S C	
S D	
S E	
S F	
S G	Special classified stores for grinders.
S H	
S J	
S K	
S L	Special classified stores for Taylor System apparatus.
S M	Special classified stores for molding machines.
S N	Special classified stores—miscellaneous.
S P	Special classified stores for pattern fitting and repair work.
S R	Special classified stores for milling cutters.
S S	
S T	Special classified stores for Taylor-Newbold saws.
S U	
S V	Miscellaneous classified stores or stores for a variety of purposes.
S W	
S X	
S Y	
S Z	

S V — MISCELLANEOUS CLASSIFIED STORES	
S V A	Miscellaneous stores—not otherwise classified.
S V B	Brass, copper and products made chiefly from same.
S V C	Cast iron and products made chiefly from same.
S V D	
S V E	
S V F	
S V G	
S V H	
S V J	
S V K	
S V L	Liquids and products made chiefly from same.
S V M	Miscellaneous metals, other than iron, steel, brass and copper.
S V N	Composite materials.
S V P	Textile and fibrous materials.
S V R	
S V S	Steel, wrought iron and products made chiefly from same.
S V T	Tools and implements.
S V U	
S V V	
S V W	Wood and products made chiefly from same.
S V X	Mineral products.
S V Y	
S V Z	Fastening, bolts, nuts, etc.

FIG. 7. EXAMPLE OF MNEMONIC STORES CLASSIFICATION

letter is not carefully made, it should not be used. Thus there are twenty-three letters of the alphabet available for use.

To begin the construction of a classification with its corresponding series of symbols, place the twenty-three available letters in a vertical line on the left-hand side of the page and then fill in opposite to them the various major groups in the particular classification being symbolized. This first sheet is known as the base sheet, on which it is frequently necessary to use nearly all of the twenty-three available letters. For later sheets in the classification it may not be necessary to use more than two or three letters. (See cape chisel sheet in Tool Classification, Figure 4.) For each letter utilized on the base sheet another sheet must be provided in the complete classification on which in similar fashion the various units which the group includes will be scheduled—each under its appropriate letter.

It is usually convenient to designate the several breakdowns, or subassemblies, in the worked-material classification as groups, divisions, sections, and so on, in the order of their respective succession. When a series of subassemblies extends still further, resort to such terms as subsection, sub-subsection, and so on, is necessary. For sample sheets from a number of different classifications with their symbolizations see Figures 7, 8 and 9. A study of these will show the general principles governing this type of symbolization.

In designing classifications which are largely listings, such as the tool and stores classifications, effort should be made to design the groups and especially their successive subdivisions so that they will not require over eight or ten letters. It will soon be discovered that after eight or ten letters have been used the difficulty with which the series is kept mnemonic increases very rapidly. When it is desired to add one or more items to the series after eight or ten letters are preempted, it will be found that in too many instances the letters which would be most significant, and therefore the most highly mnemonic, have already been assigned to something else. In the base group of a series, and in the subdivisions which immediately follow, it is sometimes possible at the beginning of the work to determine all the items which go to compose it, and in such cases all the twenty-three letters may be utilized. In those groups where additions must be made from time to time, or even where changes in all probability will have to be made, plenty of room for expansion must be left. It is inadvisable to have the groups consist of less than eight or ten items on an average, as this would make the whole system too much spread out and result in symbols unduly long.

As any terminology built up prior to classification is almost sure to be indefinite to the point of being inaccurate when classification is

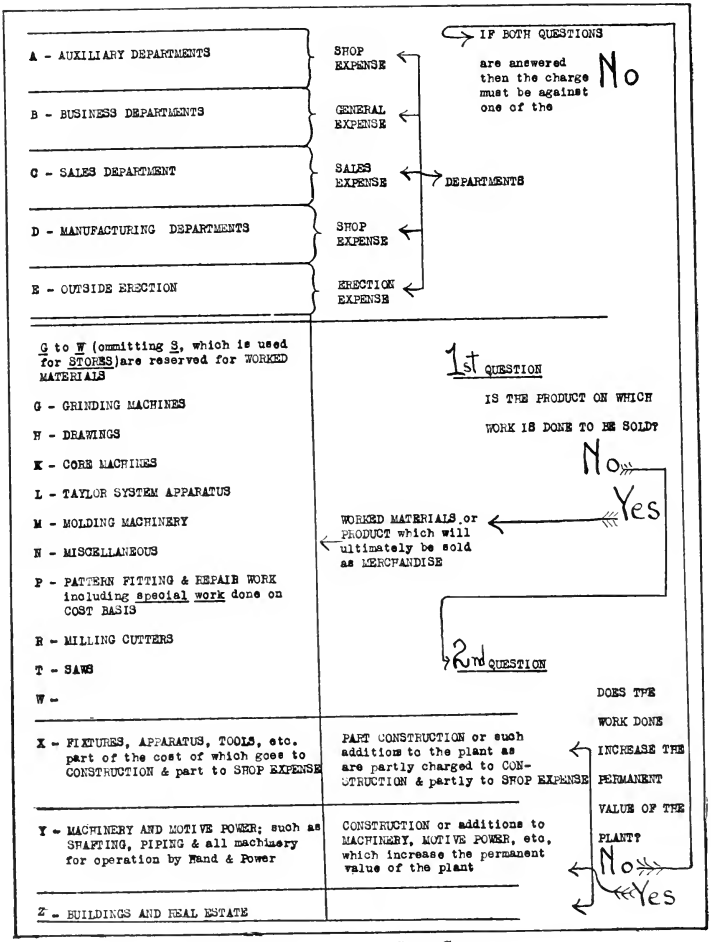
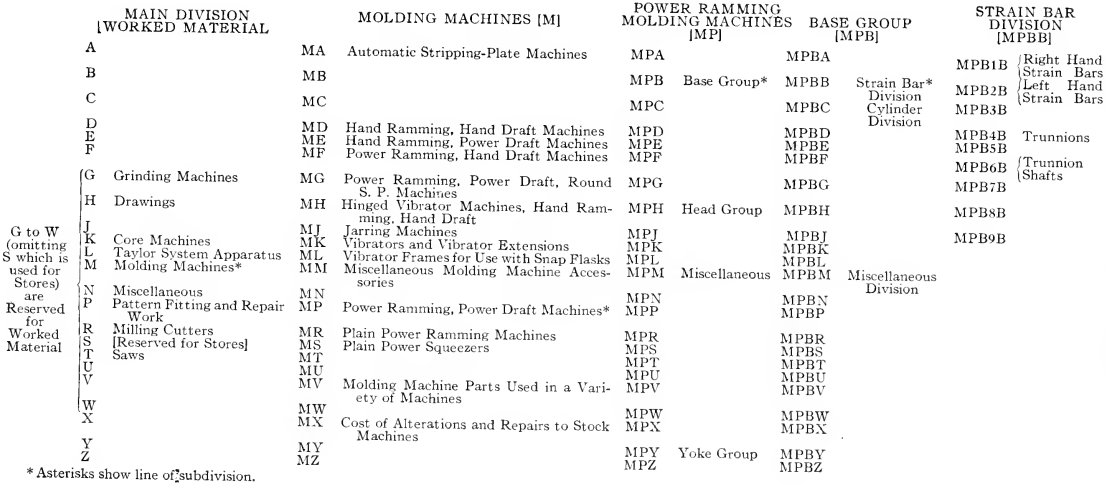


FIG. 8. BASE SHEET OF COST CLASSIFICATION



* Asterisks show line of subdivision.

FIG. 9. EXAMPLE OF CLASSIFICATION OF WORKED MATERIALS AND PRODUCT

undertaken, one must be prepared in such cases to adopt a radically different terminology. Especially in the older trades, as for instance in printing, we encounter practices, tools, and so on, which in the course of time have become so changed as to make the historic names far from descriptive. When changes in terminology become desirable it is frequently possible in the adoption of new names to choose those which specially lend themselves to mnemonic symbolization.

In assigning a symbol to a given term it is not always possible to use the first letter of a word, and even when possible it is not always desirable to do so. When the first letter is already appropriated, it is usually a good rule to use the second, or some later letter conspicuous to the ear when the word is pronounced, unless there is some reason to the contrary. The same rule will apply when the word begins with one of the three dropped letters (I, O and Q), as with "insurance," when the letter N may be used.

It frequently happens that when a letter has been appropriated for one item and there is a second demand upon it, the first assignment should be abandoned. Before a series of symbols is put into general use, even radical changes which will tend toward improvement should be freely made. After a system has been in use for some time, suggestions which might mean radical improvement are likely to occur. It then requires good judgment to decide whether to make the change. For, if it is made, it means that wherever these symbols are used in the instructions of the establishment corrections must be made. When it is remembered that a system of symbolization, properly constructed, will last over a long term of years, there is every argument in favor of having it as nearly right as possible, even though it is necessary to revise the series a number of times before obtaining the final result. Even the most experienced designers of classification frequently have difficulty in deciding upon a suitable letter to use when confronted with a given set of conditions. It is also frequently difficult to decide when a rearrangement of the classification is warranted. For these reasons it is desirable to begin the construction of the various classifications required some time ahead of the date when it will be necessary to actually put them in use. After they have been put in use, changes, and especially radical ones, are to be deprecated but infrequently cannot be avoided.

There are some words which run all through a system, appearing in many different groups. Such a word should always be favored by having assigned to it a position as mnemonic as possible, and every effort should be made to give this word the same position in every group where it occurs. When choosing a symbol for a word which will be used frequently, it should be given the preference over a word

which will be used less often. On the other hand, it does happen that a non-mnemonic letter for a frequently occurring item or word soon becomes memorized. When an item has two or more possible and equally good names, the mnemonic quality in the symbol can frequently be secured by choosing that name for which the most appropriate letter is still available. There are some letters, which rarely begin words, that appear in ordinary classifications, such as K and V. When these letters appear within words, it is good practice to select them for the symbols as they are easily distinguished, and this leaves the letters which are more in demand available for subsequent use. Thus choose K for "ink," and V for "inventory" rather than N, which is the second letter in each case and which is therefore the one which would ordinarily be used, since I is not available. For the same reason, K for "check" and Y for "employee" may be used. The letter A has been used quite generally for "miscellaneous," a category which under scientific management must be kept small. This letter will be found convenient also as a temporary resting place for items the ultimate disposition of which has not been determined, a contingency frequently occurring in cleaning up a tool or store room where articles are found for which there is no apparent use.

When both the first and second letters are wisely appropriated to other words, the last may frequently be used to advantage. Another expedient is illustrated by the use of the letter R (revolutionary) to stand for 1776 when these numbers describe a brand. It frequently happens that the meaning of a symbol can be ascertained by a more or less unconscious method of elimination. Thus if there are eight items in a group and seven are mnemonic, the other becomes more or less so by elimination and contrast. Only experience in the use of symbols will reveal all the direct and indirect methods by which they are made mnemonic.

In using integral or fractional numbers they should precede the letter they qualify except in the case of a number placed at the end of a symbol in either the stores or charging (including worked material) classifications indicating a lot number. A number placed in front of a symbol in the worked-material classification indicates the number of the operation in the series of operations which have to be performed on that piece. In the symbol 3M7H1C5 the initial figure 3 indicates the third operation performed on all pieces symbolized by M7H1C5 (the 5 indicating the fifth lot of the cylinder group, C, of seven inch, 7, hinged vibrator, H, molding machine, M). This use for indicating successive operations in the process of manufacture is illustrated on the route chart with operation symbols, see Figure 10.

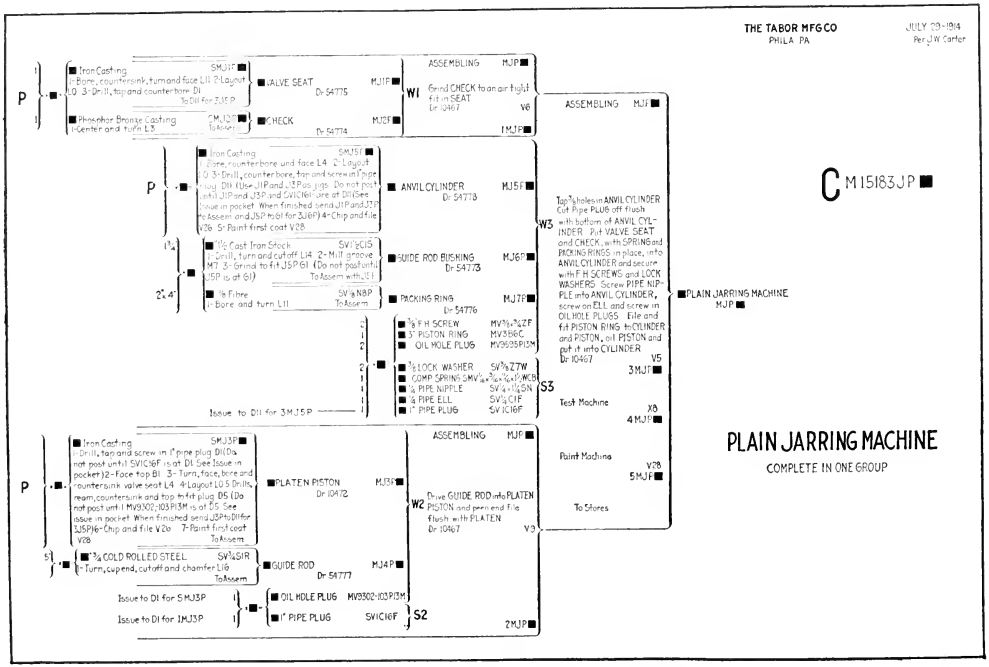


FIG. 10. ROUT CHART WITH OPERATION SYMBOLS

By avoiding all punctuation, and using brackets only when absolutely necessary, it is possible to write mnemonic symbols with a minimum of effort and time. It frequently becomes possible to drop letters from the left-hand side of a symbol when used for some specific purpose. Thus in a department where only one series of symbols is used, it is sometimes unnecessary to carry the one or more letters on the left which differentiate this series from others making up the system in use throughout the establishment. It is good practice to begin with every letter in its place. After every one has become thoroughly familiar with the system, it often becomes possible to allow certain letters to be omitted in writing the symbol, because they are understood. These letters will always be the initial letters or those on the left-hand side. Thus, to assist in the routing of supplies and worked materials through a certain printing establishment, a mnemonic system was devised by means of which each and every bin, closet, shelf, table or square foot of floor space could be designated by four letters. The base sheet carried four letters, B for "bindery," C for "composing room," P for "press room," and S for "store room." The subdivisions of the space in each of these four departments were indicated by the three letters which were placed to the right of the letters indicating the department. Thus CABK indicated a certain type case in the composing room and CLMA indicated a compartment in a certain galley rack in the same room. For purposes of the composing room only and on records which are never used outside of the composing room when used, as in marking proofs, to indicate that it is a location symbol, ABK and LMA will answer every purpose answered by CABK and CLMA.

In certain cases the memory can best be assisted by grouping rather than by the usual method of picking the letter which begins a word to represent it. Instances of this kind are shown in Figure 8 (the base sheet of the classification of charge accounts). Here the middle section of the alphabet is reserved for the product called "worked materials." In the same way, in this same column it will be noted that the letters X, Y and Z are reserved for charge accounts of a certain general character—plant charges.

Interlocking as a Factor in Classification. The classification of tools (see Figure 4) represents a very elementary type. It is a simple listing of items where it is unnecessary to suggest any interlocking relation between items or groups of items. There are classifications, however, where the opportunity to indicate cross relationships becomes of first importance. In the case of purchased tools, of which a reserve is always kept in the store room, a relation is necessarily established with the stores classification. A first step in the direction

of interlocking is shown in the Stores Classification (see Figure 7), which is a listing of all purchased articles of every kind and description.[1] Here it will be observed that, while the great majority of letters are reserved for stores used on specific items or classes of product the letter V is utilized for the grouping of articles used for a variety of purposes. Carl G. Barth has adopted a somewhat different scheme for classifying stores. He first divides stores into two main classes, *i.e.,* unclassified and classified. Items of unclassified stores are symbolized by an S followed by a serial number. Classified stores are again divided into (1) miscellaneous classified stores (stores used for a variety of purposes), symbolized as SV and (2) special classified stores. The latter are further subdivided into (1) special classified stores used for worked materials and (2) special classified stores used *other* than for worked materials. Under SB, for instance, Mr. Barth places all office materials including stationery. Thus he avoids the use of the V by which the symbols for all items used for a variety of purposes is extended.

In classifying stores one or two leading thoughts may be followed: (1) according to the use made of an article and (2) according to the material of which it is made. Depending upon conditions either may be the best. For instance, in the plants of the Link Belt Company lubricators were classified as articles made principally of a certain material, as cast iron or brass. Whereas in an engine-building concern for which lubricators are of more importance, they are given a class of their own where use is the determining factor.

The number of items which must be included in the stores classification for enterprises of average size is so limited that reasonably short and compact symbols are possible. But this is not always so. The Western Electric Company is reported to handle over 50,000 different items in its various store rooms. It was estimated that the United States government shipped 125,000 different items to Europe during the Great War. Of course, a company having plants at various points can to advantage adopt a common stores classification, available for each plant. The ease with which classifications can be duplicated and made available for different plants of one company offers a distinct argument in their favor.

While it is possible to develop any classification as a study in itself, so that it will have little if any relation to any other, on the other hand it is sometimes possible—even easy—to effect combinations, as

[1] Articles purchased but once and with no prospect of a repeat order, and other items purchased at long intervals, are given a special treatment so as not to burden the classification. Such items are simply listed as unclassified stores, and for the time being symbolized by a letter S followed by a number.

in the case of the classification of charge accounts of the Tabor Manufacturing Company (see Figure 8) which includes the worked material classification (see Figure 9). The classification of charge accounts is arranged so that any charge will eventually be placed on that part of the product—just begun, partially completed or finished—for which the expense has been incurred. Worked material is product in the process of making—single parts, assemblies of parts, assemblies of assemblies, and so on—all in various stages of manufacture or completed. Worked material always includes also the final product until transferred on the books from the worked-material account to the merchandise account. Worked-material symbols must be so designed that the symbol for each individual part clearly shows its relationship to the final finished product.

"Other things being equal," the broader and more inclusive any classification can be made the better it will be. But as things never are "equal," the relative inclusiveness of a classification almost inevitably becomes a matter of compromise. As time goes on and standardization becomes more general in the fields affected by management, the technique of the drafting of classifications will doubtless be so developed that some of our present-day efforts may seem pretty crude.

Carl G. Barth, who brings a philosophical mind to bear on the problems discussed in this chapter, suggests the rule that, in a worked-materials classification, an ultimate article that will not form a part of a bigger thing (assembly) must have a symbol consisting of not less than two letters with a number between. At the Watertown (Massachusetts) Arsenal, K6D was the symbol for a six-inch, disappearing-gun carriage. K is the letter assigned to all gun carriages, D to those of the disappearing class, and the figure 6 represents the size, *i.e.*, the bore of the gun. If, to distinguish one design or modification from another, a letter to designate such certain model is to be added, as for instance B for "model B," this *must* precede the number 6 and not follow the whole fundamental symbol K6D; thus KB6D. If instead, this letter B were added we would get K6DB, which would be the symbol for a B group of the ultimate assembly K6D.[1] When there are a number of models, K6D may well stand for KA6D, the first model, where the letter A is simply omitted to save space; just as for short, and without room for misunderstanding, we write in mathematics only a for $1a^1$ but *must* write $5a^3$. As in the case with the letter designating the model, so any other letter required to designate the article more

[1] However, when a final article is so simple that it is at once assembled from individual parts, its symbol must, unfortunately, have the appearance of a group of a more complex whole, as is the case with the molding machine assembled in Figure 10.

fully must also precede the numerical part of the symbol. Such considerations as this have great importance in the classification and symbolization of a machine having more than four thousand parts, as was the case with this and other gun carriages. Where, with the object of shortening symbols, we dodge fundamental rules, symbols with numbers having no mnemonic quality are apt to be the result.

As has been explained, the operation symbol is developed from the worked-material symbol of the part or group of parts on which the operation is to be performed. On the route sheet (see Figure 10) is shown the use of operation symbols as well as stores and other symbols in the manufacture of a very simple molding machine.

In the manufacture of a product like men's clothing in which there are relatively few operations (usually less than 150 in a three-piece

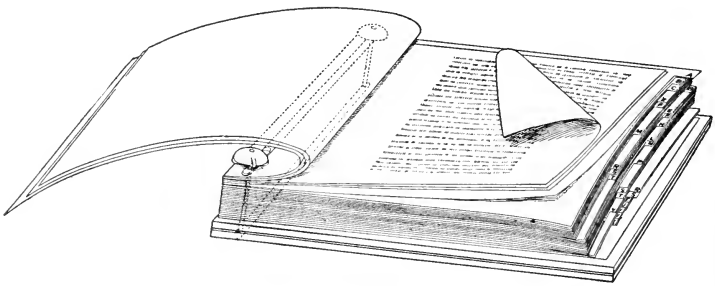


FIG. 11. UNIT OF A STANDING ORDER FILE

suit), it is possible to devise a worked-material classification in which the same part of a suit will always have the same symbol in whatever style combination it may occur. Every type and variety of product suggests new problems, both of classification and symbolization.

Information Indexes. One of the principal functions of classification and its attendant symbolization is to facilitate indexing. With the general advance in knowledge and the collecting in each plant of data about specific matters—about operations, processes, tools, and so on—it becomes increasingly difficult to record the accumulated information so as to make it readily available when wanted. Unless there is some place where instructions [1] once issued can be filed in orderly fashion, it is only a question of time, and sometimes a very short time, until these fall into partial or total disuse. For this reason scientific management has suggested the use of a standing order file where

[1] For a classic paper on the use of mnemonic symbols in drafting instructions see Williams, John H., "On the Index as a Factor in Industry," *Bulletin of the Taylor Society*, Vol. II, No. 2, July, 1916.

all instructions can be placed so that their maintenance in good fashion can be made the responsibility of some one agency. These instructions need not necessarily all be located in one place. The physical aspects of one of the units of such a file and the method by which symbols are utilized for indexing purposes are illustrated in Figures 11 and 12.

One suggested method of providing an all-inclusive classification for indexing purposes is to take the standard classification of charge accounts (for base sheet, see Figure 6) and insert in it, in places not otherwise preempted, those classifications, such as stores, not already

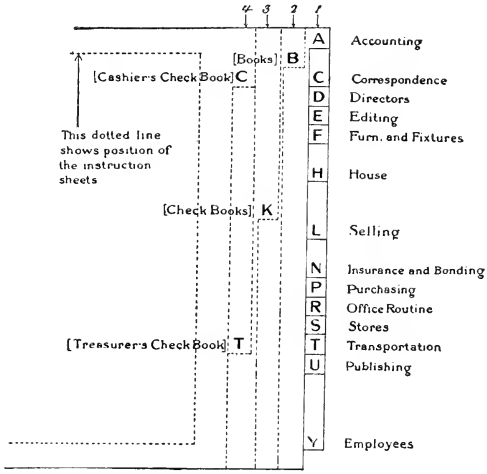


FIG. 12. INDEX SHEETS OF STANDING ORDER FILE

included in it. In any such scheme machines and work places become a subdivision of Y, and tools a subdivision of X, and so on. This is the equivalent of tying together in a master index classifications not otherwise related. Symbols for charge accounts as a rule consist of three letters, but for indexing purposes these symbols may be carried to four and five and even six places without becoming unwieldy.

The frequency with which changes in instructions and additions to data are made sometimes acts as a discouragement to orderly recording and indexing and filing. But it is possible to reckon the number and volume of additions and changes out of proportion to the great mass of material which, whether recorded or not, constitutes the standing orders of any industrial enterprise. It is, of course, not worth while

to make and file records which are immediately to become obsolete. The system recommended involves giving to each matter taken up enough thought and study to give the conclusions permanency.

Every improvement made in the organization of an industrial enterprise makes other improvements possible. In any thriving business standards which today are perhaps fairly satisfactory appear crude tomorrow by comparison. Then again changes taking place all the time in that part of the industrial field in which any particular organization is operating constantly suggest and force changes within the organization. In fact, most managers would feel apprehensive if demands coming from without the organization were not constantly facing changes within it. New inventions, new ideas, new lines of endeavor, new customers, are all essential to progress and even to industrial life itself. Every change on the outside causes a corresponding change within. The correspondence of the internal organization with its field must be kept as close as possible. All this inherent change, therefore, both from within and without, keeps any industrial enterprise from ever finally perfecting its organization. But this should act as a stimulus toward, rather than as a deterrent from, as perfect an organization as possible.

The final goal toward which all classification tends is to have each part of an enterprise so located in the general scheme that its relation with every other part is not only definite but readily distinguishable. Good management must insist on ever pressing toward a goal, all the while recognizing that the goal can never be fully reached.

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CHAPTER X

FUNCTIONAL ORGANIZATION [1]

"ORGANIZATION is the process of so combining the work which individuals or groups have to perform with the faculties necessary for its execution that the duties, so formed, provide the best channels for the efficient, systematic, positive and coordinated application of the available effort." [2]

An organization is therefore essentially a complex of relationships of parts to the whole and to each other; more specifically of such factors as things to be done, persons doing them, methods of doing them, facilities for doing them, responsibility and authority. Under division of labor requiring the coordination of factors separate in time and space, the effectiveness of individual effort as contributing to the common purpose is in very large measure dependent upon an understanding of this relationship by the coordinating unit, and in no small part upon understanding by every other member of the group. It is for this reason that an enterprise should realize that it is inevitably an organization, and should make the nature of the organization known to all concerned, that all may have common understanding of it.

But the analysis of a whole into its parts, and a delineation of their relationships, is a function of the mind. It is a result of observation and qualitative classification. The background of the observer and classifier will have a bearing on the result of his analysis. It is for this reason that there have appeared various theories of organization.

Theories of Organization. There are two radically opposed theories of organization. The first is based on the assumption that "they should take who have the power and they should keep who can." In other words, this theory is based squarely upon the survival of the fittest. For that reason it has much to recommend it. Since there is a minimum of restraint upon individual initiative, it tends to bring forward the strong dominating personality. It assumes to set up no definite limits of authority or responsibility, but gives each man a free rein, within reason, to grasp and make effective the amount of authority which he can secure to himself. One's subordinates are limited only by the numbers of persons who submit to one's authority. One's equals are determined by the results of day-to-day contact.

[1] By Henry H. Farquhar, Hahn Department Stores, Inc., New York.

[2] Sheldon, Oliver, *The Philosophy of Management,* New York, Prentice-Hall, Inc., 1923, p. 32.

This type of organization, however, has serious drawbacks. The man who has the dominating personality to push himself ahead in this free-for-all scramble for authority is not necessarily the type of man who is really best fitted to wield the resulting authority. He may not appreciate that there can be no real authority without corresponding responsibility. One situation may demand the utmost aggressiveness in management—the active dynamic leadership usually associated with aggressiveness; but another may demand much less aggressiveness and a much more contemplative type of mind.

The result of this struggle, furthermore, may be that the individual will absorb unto himself more functions than he can really carry effectively for the best good of the group as a whole. He is apt to seek new worlds to conquer before he has effectively mastered the functions already gained. The result also is likely to take the form of dodging responsibility and shifting the burden for unsatisfactory accomplishment on to other shoulders. There is often an insidious, but nevertheless a serious, tendency to suppress the initiative of the man's associates and subordinates, resulting in a hesitancy on their part for fear of consequences. The man who leaves may after all be excellent executive material if led instead of pushed.

One of the most serious objections, however, is that this type of organization does not permit *measurement* of accomplishment. It is undefined in area and shifting in its ramifications at any particular time; and therefore cannot effectively have put upon it any yardstick of appraisal. Management has devoted many years and much scientific thought to improved methods of operation and to means whereby individual and group effort may be increased in efficiency. It is beginning to devote, and must continue to devote, much time and effort to measuring actual accomplishment against reasonable possible accomplishment. Any form of loose organization preventing a nearer and nearer approach to measurable analysis of effective execution serves to retard or make impossible strict measurement.

Another most serious objection is the lack of permanence when one man dominates the whole situation. Numerous instances could be cited where, upon the death of the one man around whom all activities revolved, the firm was at once thrown into an extremely serious position. It is sufficiently serious when the leading spirit in even the thoroughly organized undertaking is removed; the matter becomes much more serious when this man is allowed to be really the center of gravity of the whole undertaking.

The second theory of organization demands that there be a careful predetermination of the best working relationships between the

natural functions of a business and between the persons who are to conduct them. Such organization, in common with the recognized approach to business problems generally, is arrived at through careful research, thorough analysis and intelligent formulation of structure in the light of the particular problem. The result is a standard for organization under particular conditions, as deliberately and scientifically determined as a standard for a production process might be determined through time study, although perhaps less definite.

General Principles of Organization. The manager who takes this latter view of the matter desires his organization to be formulated with the following in mind:

He wants his organization to be designed to suit the particular problem in hand. The organization or framework around which revolves the day-to-day conduct of any business must be the solution of a particular group of problems under particular local operating conditions. Organization is simply one tool of administration—its design one of the many problems of the administrator.

He wants the functions of his undertaking to be divided according to the capabilities of the human beings upon whom he must depend. There are certain types of mind clearly recognized and definitely utilized by the manager. There are certain types of functions in any industrial undertaking also clearly recognizable. In building his organization the given type of mind and corresponding type of function must be brought together for effective operation. A function requiring at the same time great energy and a strong imagination should not be linked together with a function requiring methodical analysis or painstaking research, simply because the individual who possesses these characteristics in combination is exceedingly rare.

He wants authority and responsibility clearly defined at any particular time, but under conditions which readily permit of changes according to changes in the business and the number and capabilities of average human beings. There should ordinarily be no question for any extended period in any one's mind concerning the functions for which he and his associates are responsible, and the exact relation between allied functions and their subdivisions. It must also be perfectly clear that when a definite responsibility is set up there must be delegated at the same time adequate authority effectively to discharge this responsibility.

The progressive manager wants each individual to be limited in the function he performs, but to be unlimited in the area over which he exercises that function. As has been indicated, functions should be defined so as to match human limitations and aptitudes, allowing free play for maximum specialization. The administration of a prop-

erly determined function or subdivision of a function, therefore, should be put in the hands of one whose knowledge of that particular function justifies giving him maximum authority in it. His authority should be limited to the particular function assigned, but in that function he should have full authority throughout the entire organization.

The manager, however, in adhering to the principles just outlined will take care that no water-tight compartments in organization are set up. Modern size and specialization in industry necessitate specialization as regards both individuals and departments; nevertheless, after setting up such specialized parts of the organization, great care must be taken to see that these departments cooperate in considering and securing the best good of the undertaking as a whole, and that no individual or department assumes a "hands-off" attitude toward other individuals or departments. After setting up these departmental walls, in other words, they must then be knocked down again, figuratively speaking, so that the business as a whole will move forward as effectively as though administered by one general manager possessing all the technical knowledge and the managerial ability possessed by each of these units. The methods of accomplishing this coordination extend into the field of managing, treated elsewhere in this volume. It is important to emphasize, however, the utmost necessity of working in harmony and controlling all activities through predetermined plans and mechanisms, and in developing team play to the highest degree.

The manager, finally, wants his organization as a whole, and with respect to each unit, definitely measurable as regards day-to-day operations. By following the principles of organization as outlined, a prerequisite has been set up for effective measurement. Through following this by allocating to each function both achievement and the expenses incident to its operation, a long step is taken toward securing effective measurement.

Summing up the matter, the fundamental requirements for effective organization are: its development on a functional basis with authority corresponding to responsibility and a definite interlocking of achievement and expense.

Kinds of Organization. 1. *Line or Military.* (Figure 13.) In primitive times there was apparently only one form of organization—that derived from the dominant kind of organized activity—fighting. All activities were handled personally by the chief. This simplest, and in many ways best, form of organization lends itself to rapidity of decision coupled with immediate translation of decision into action. The one strong man possessed the limited technical knowledge that was required in early times, together with the proved administrative ability, to get results. He alone was responsible for operations and

upon him alone rested all the authority. When the *number* of men under the chief became so great that he could not personally supervise them, he appointed assistants, each of whom, in theory personally representative of his chief, was responsible for *all* activities of the men immediately under him.

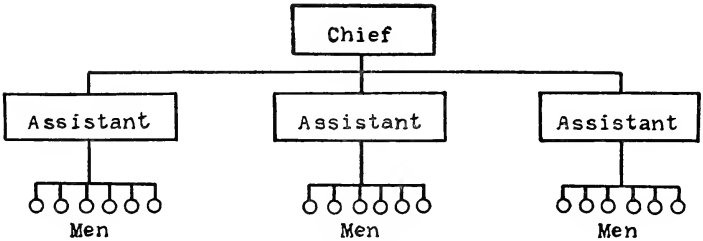

FIG. 13. MILITARY OR LINE ORGANIZATION

With the increase in kind and type of problems to be solved and of varying conditions under which such problems had to be solved, the form of organization gradually changed to a more complex type. These changes took place both in the military establishment and in industry, bringing changes in organization first in military matters and later in industrial operations.

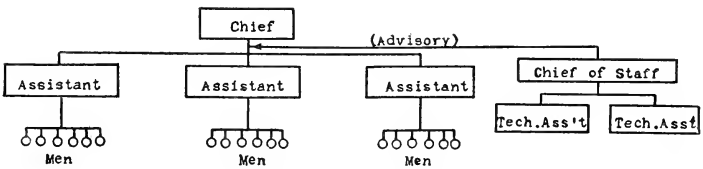

FIG. 14. LINE AND STAFF ORGANIZTION

2. *Staff Organization.* (Figure 14.) Because of the increasing *technical* problems involved in modern warfare, a somewhat different although not necessarily distinct type of organization arose. This is the so-called "staff" organization which really left the "line" form intact, but supplemented it by having a corps of experts attached to the commander-in-chief in a purely advisory capacity. Such staff organization, originating in the military, introduces the general principles underlying modern functional organization so far as specialization goes, but leaves the fundamental concept that to specialized knowledge in such matters should be attached a certain degree of authority.

The staff idea of the army was copied bodily by industry as one attempted solution of problems of organization confronting business men.

3. *Functional Organization.* (Figure 15.) Functional organization is the form of organization under present industrial conditions conceived by Frederick W. Taylor. (The term "instructional organization" is more descriptive of the real nature of this type.) His concept embodied the specialization feature of the staff idea, but added the further requirement that instead of the staff expert remaining outside of the lines of authority, he was brought back into the body of the organization and given authority and responsibility throughout all phases and all operations necessitated by the activities of the particular function. The description given will clarify some popular misconceptions as to the difference between so-called staff organization and functional organization. The idea underlying the one is expert knowl-

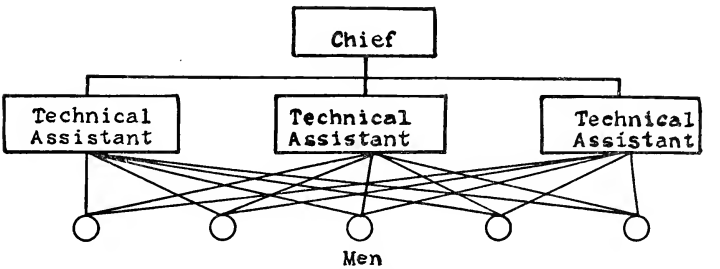

FIG. 15. FUNCTIONAL ORGANIZATION

edge offered in an advisory capacity only; the idea of the other is expert knowledge coupled with authority to make that knowledge effective in practice.

The customary division of industries into different departments, such as sales department, production department and financial department, is not only simply a logical subdivision of labor necessitated by the scale of present-day operations, but is absolutely consistent with the functional concept of organization. These departments, in other words, getting at the matter broadly, are merely functional subdivisions, corresponding to technically different groups of activities, of the work of managing the enterprise as a whole.

A further misconception, however, should be cleared up. The subdivision of an organization into sales, production and financial departments does not constitute functional organization as developed by Taylor. These are simply logical subdivisions of the general manager's burden, neither new nor radically different from what has been

going on along the lines of division of labor for centuries. For the real difference one must go below the upper strata of activities and search throughout the whole group down to and including the workman at the bench. If throughout this group he finds that the natural functions in every case, including the work of the man at the bench, have been definitely determined and entrusted to the responsibility and authority of some one functional official, unlimited in area and supreme in his own functional field (except, of course, as in all cases, channels of appeal in cases of disagreement must be established), then he finds the true functional organization designed and so effectively used by Taylor. An individual workman may thus report to one functional or instructional supervisor for one part of his work and to another for a different part; for instance, to one for instructions as to what to do next, to another as to how to do it properly.

Functional organization has certain disadvantages. Although it must be true that there is still at the head of the undertaking one final source of authority and responsibility, nevertheless the functional method of assisting that one man to carry the burden does tend to slowing up of decisions and slowness of action in case of emergency. In functional organization speed is sacrificed to informal deliberation. This fact may have serious disadvantages or advantages, depending upon the kind of problems arising under particular circumstances. The fact remains, however, that this functional form is inherently slower in meeting emergencies than the straight-line form of organization.

The possibilities of functional organization vary almost directly with the degree to which standardization replaces variability throughout an enterprise. If an enterprise is in every part subject to numerous unexpected situations, requiring quick judgments, decisions and actions, if there is not a well-defined purpose and system of correlated means of accomplishment clearly understood, then functional organization becomes difficult to establish and maintain.

The general advantages of the functional form are:

a. It sets up authority and responsibility along logical, functional lines dictated by the technical units of activity and the mental characteristics of the ordinary average individual in industry. This at once tremendously widens the field from which even minor executives can be chosen, since without this logical subdivision of work only the very exceptional individual can hope to rise to any degree of complicated administrative work. It issues an invitation to the rank and file to avail themselves of any one of the more numerous, but more strictly prescribed, executive positions available.

b. It defines and limits authority and responsibility. Strict definition of limited activities lends itself to stricter measurement of results

accomplished and has a minimum of vagueness as to the content of any individual job and as to who may be responsible for any activity.

c. It places definite emphasis on responsibility rather than on authority, since authority under this type of organization is definitely identified with knowledge as expressed through accomplishment. And since accomplishment may be fairly accurately measured, authority may be curtailed or extended accordingly.

d. There is established a freedom of horizontal contact between administrative officers to a greater degree than is true with other types of organization. Executives on the same plane of authority are constantly rubbing elbows with each other as one after another comes in contact with the same subordinates, each taking up his particular functional duties with these subordinates. This serves to break down departmental walls and tends to force team work. In case of disagreement—which of course occurs more often under functional organization than in other types, and which may become serious if functions are not carefully defined—appeal is taken to the next higher strata, resulting possibly in a further extension of horizontal along with vertical contacts.

e. Finally, this form of organization provides for the fullest use of individual personalities, aptitudes and abilities, by setting up specialized functions requiring specialized types of mind operating under predetermined but easily revised relationships.

Measurement of Performance. The principal forms of inspection of the results of effort are treated in Part IV. At this point, however, it is desirable to emphasize the fact that appraisals of individual and departmental efficiencies—whether in terms of output or in terms of cost—are promoted by functional organization with its clear-cut delineation of responsibility along lines which are distinguishable in terms of natural functional parts of a whole. The allocation of expense, for instance, and measurement of performance in terms of expense, is almost impossible in organizations in which departmental and individual responsibilities cross the boundaries of natural functional areas.

Committees. The proper place of committees in an organization is more clearly perceived in functional organization. Experience has led to the conclusions, apparently inconsistent, on the one hand, that committees are inefficient as instruments of execution, and, on the other hand, that they have certain high values. Under the theory of organization that he who by personality, force or otherwise can get the power shall make the decision and give the order, committees may run amuck, and become either the impotent reflections of a dominant personality, or in the absence of such a personality, an inefficient

body without power of concentration, common agreement and execution. But under a functional form of organization, the natural functions of a committee may be delineated, and the value of that instrument be utilized.

The responsibility of making judgments—determination of policies, decisions as to projects, construction of plans and schedules—should be distinguished on the one hand from the researches which secure the data on which judgments must be based, and on the other hand from the execution of the judgments. As individual activity becomes more complicated, units of enterprise larger and their contacts more diverse, and as the determination of facts by scientific method becomes broader, at the same time the field of determination of the significance of facts becomes broader and beyond the capacities of single individuals. Also, the more departments are coordinated into parts of an integrated whole and the more their objectives are to work together without functional loss to achieve a common purpose, the more difficult it becomes for departments alone to make decisions on departmental policies and plans without intimate knowledge of this influence on other departmental policies and plans. Furthermore, the burden of unassisted coordination is becoming too great for any one "chief" executive to carry. For these reasons there is an important functional place for committees in various strategic centers of the managerial area; for instance, an executive committee of department heads assisting the general manager in making decisions concerning general policies and plans; a committee of unit heads assisting the department manager in making decisions pertinent to the department; and special committees making decisions and recommendations concerning special problems covering all departments, such as a committee appointed to study the problem of establishing unemployment insurance.

The development or discovery of leaders among younger members of an organization, to replace older executives as they retire, is now recognized as a problem. The tendency of functional organization to promote self-development and self-expression should be enhanced in value by utilizing committees as a training ground for the participants. Modern psychology has discovered the significance of differences in individual capacity and the extent of these differences; and one of the problems of management is likewise to devise means of discovering these differences. Research capacity and capacity to execute decisions are not so difficult to discover and develop; but the capacity to make sound judgments—perspective, logical acumen, common sense—are not easily discovered and developed. As an instrument for the discovery and development of such capacities the committee has a high value.

Discovering the Organization. It is our point of view that the organization for any particular enterprise is discovered and not arbitrarily made; discovered in the technical requirements and personal assets of the particular situation. Accepting this point of view, the proper practical procedure of discovery is somewhat as follows: first, a clear definition of the objective of the enterprise; second, a technical analysis by main and subdivisions of the ways of accomplishing the objective, regardless of the availability of a technically competent personnel; third, a survey of available personnel from the point of view of capacities; and fourth, a reconsideration of functional activities in the light of available personnel. Such a procedure should result in a picture of things to be done and their relationships in terms of capacities available—an organization plan.

In a small enterprise one individual possessing the requisite combination of capacities may often have to assume responsibility for several related functions; in a large enterprise one function may have to be assumed by several associates. In any enterprise there may be side-by-side functions which, because of differences in volume of work, are one-man or several-men responsibilities—but in any case functional delineation of activities promotes the matching of capacity to responsibility and the appraisal of performance. In these days of complicated industrial enterprises, the organization which depends upon chance-acquired activities of its personnel has less likelihood of enduring than the organization whose members are fitted to functional—therefore, inherently related and distinguished—responsibilities, and have a status determined by measurement of performance.

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CHAPTER XI

GENERAL ADMINISTRATIVE STANDARDS[1]

In these days of keen competition and constantly changing market requirements, every efficiently operated corporation must set up scientific administrative standards if it wishes to hold its place in the race for industrial supremacy. Although such standards may be established by the use of a general formula, yet the basic conditions in each type of activity must be taken into account in applying its principles. When once set up, these administrative standards serve as a measure against which the actual performance may be checked.

The purpose of such standards and check-ups is the coordination of all the several activities of the business. Standards establish objectives for the entire business and coordinated objectives for each major department in relation to the whole, and consequently they afford a basis for the achievement of the business as a whole and of each major department. The administrator cannot sidestep this task of coordination. To a large extent he may hire assistants to do most of the other work but he cannot avoid responsibility for adequate coordination.

The primary device for securing this coordination control by use of administrative standards is the company budget, a well-rounded picture of the probable sales and production, income and expenditure, and profit or loss of the enterprise for a definite future period.[2] The budget may be made in as much detail and covering such periods as the needs of the business and the intricacies of its administration may call for. Experience has shown that a simple budget plan will gradually extend into as much detail as is called for by the requirements of the individual institution and the ability of its executives to make use of such an effective administrative instrument. The budget is a means of interpreting current and proposed activities, and through it developing trends can be seen soon enough to adopt corrective measures.

The General Budget. As relates to the sequence of events, the general budget is the last to evolve in the process of preparation, but there are advantages here in discussing the philosophy and design of the general budget first. The primary principle to be recognized in establishing budgetary procedure may be called the principle of the "pyramid on its base." This principle pertains to the necessity of

[1] By Howard Coonley, President, and Joseph H. Barber, Assistant to the President, Walworth Company, Boston.

[2] Cf. Chapter XIX.

building upward from a mass of detail through successive levels of subcontrols or summaries until finally, from a single vantage point at the apex of the pyramid, the administrator should be able to trace activities through certain functional or other lines of control so that he is assured of balance in all man-power activities. A second side of the pyramid may deal with territorial markets, which through various classifications may summarize sales by territorial areas and by classes of customers. The third side of the pyramid would deal with the financial accounts devised so that a system of subsidiary and controlling ledgers will finally yield one master profit-and-loss statement and balance sheet. The fourth side of the pyramid relates to non-financial accounting, whereby a multitude of product items is analyzed to reveal dependable summary indexes of product trends, assortments, prices, and so forth.

The administrator is not concerned with the sides of the pyramid only. In practical operation there are many cross lines between the sides of the pyramid. Some precautions are made necessary because of such complexities, the most important being: (1) the accounting classification should be built up according to organization responsibilities; (2) budget schedules should be made in terms of the accounting classification; (3) each separate estimate item should be made by the person designated to perform the task; (4) the estimate items should be reviewed and assented to by the responsible superior officers who are to control execution.

Assuming that departmental estimates have been prepared and correlated according to suitable procedures, it becomes possible to set up a master summary as indicated in Figure 16. This table represents the summary page of a monthly budget estimate. It illustrates what the administrator can see at the apex of the pyramid as he casts a glance forward each month. Reading downward he finds listed all of the active units of the company. Reading across the page he finds a cross section of all activities of each of these units. More than likely, however, his eye drops immediately to the bottom of the page to see the combined effect of all the activities as reflected in the total shown. Faults can then be traced down to individual units through the subsidiary summaries which support the master schedule, and this corrective action will be facilitated because the organization and accounting practices have been lined up definitely for such utilization.

The Sales Budget. In preparing a master budget estimate for the administrator, it is essential that we begin estimating in the fields of greatest uncertainties; that is, we must first investigate those most variable conditions that are least subject to wilful control by the administrator. If we may determine probabilities there, then it is the admin-

istrator's task to adjust the controllable factors so as to arrive at the greatest possible net profit with the aid of, or in spite of, the uncontrollable conditions. Roughly it may be said that, assuming costs and expenses stable, net profits will be directly affected by three major variables: there may be a shift in volume, a variation in price or a change of assortment. The sales estimate attempts to anticipate the effect of all of these during the period to be estimated. There are three primary methods of approach to sales estimating:

JULY 1928 BUDGET
Walworth Company and Subsidiaries

		Billing	Purchases	Payroll	Inter-Co. Billing	Inter-Co. Purchases	Combined Billings	Combined Purchases	Cash Receipts	Cash Disbursements
1	Gen.Hdqts.	$ 236,000	$ 61,000	$ 62,000	$ -	$ 218,000	$ 236,000	$ 341,000	$ 554,000	$1,040,000
2	Division A	205,000	5,000	5,000	-	186,000	205,000	196,000	197,000	-
3	Division B	316,000	8,000	7,000	-	289,000	316,000	304,000	346,000	-
4	Division C	134,000	33,000	7,000	2,000	68,000	136,000	108,000	142,000	7,000
5	Division D	158,000	5,000	5,000	-	145,000	158,000	155,000	133,000	-
6	Division E	269,000	5,000	6,000	-	245,000	269,000	256,000	284,000	-
7	Division F	79,000	3,000	4,000	2,000	76,000	81,000	83,000	63,000	2,000
8	Boston Works	3,000	168,000	176,000	440,000	83,000	443,000	427,000	-	-
9	Kenenee Works	10,000	373,000	333,000	921,000	72,000	921,000	779,000	-	752,000
10	Greensburg Works	4,000	186,000	222,000	521,000	17,000	525,000	434,000	6,000	472,000
11	Ktna Works	4,000	6,000	5,000	13,000	2,000	17,000	13,000	7,000	-
12	Attalla Works	1,000	46,000	43,000	112,000	-	113,000	91,000	136,000	160,000
13	Branch Q	236,000	97,000	22,000	7,000	61,000	243,000	210,000	243,000	-
14	Branch R	379,000	149,000	27,000	1,000	152,000	380,000	358,000	394,000	32,000
15	Branch S	118,000	90,000	9,000	1,000	24,000	119,000	123,000	142,000	41,000
16	Branch T	134,000	83,000	17,000	1,000	27,000	135,000	127,000	137,000	176,000
17	Branch U	315,000	222,000	25,000	1,000	68,000	316,000	316,000	323,000	293,000
18	Subsidiary 1	252,000	62,000	16,000	30,000	226,000	282,000	304,000	243,000	280,000
19	Subsidiary 2	134,000	58,000	15,000	-	30,000	134,000	103,000	118,000	106,000
20	Subsidiary 3	8,000	8,000	1,000	-	3,000	8,000	12,000	3,000	5,000
21	TOTAL	2,995,000	1,669,000	1,018,000	2,052,000	2,052,000	5,047,000	4,739,000	3,471,000	3,306,000
22	Add Total Payroll		1,018,000							
23	Deduct Cash Disct.	44,000	28,000						486,000	486,000
24	Deduct Inter-Co.									
25	TOTAL	2,951,000	2,659,000						2,985,000	2,818,000
26	Financial Exp.		112,000							
27	Cap. & Other Chgs.									
28	GRAND TOTAL	2,951,000	2,771,000							

Estimated Liquidation

Commitments	$180,000
Cash	165,000

(This "Liquidation" represents the difference between net profits gained and inventory increase.)

All the figures and their relations as shown are fictitious.
None of the figures on the budget indicate the effect of any proposed note transaction.

1 Financial Expense includes: $ 46,000 Work's Appropriations
22,000 Insurance
4,000 Interest on Notes Payable
40,000 Interest on Bonds
$112,000

FIG. 16. SUMMARY PAGE OF MONTHLY BUDGET ESTIMATE

1. Estimates may be required of the local salesmen who are close to the scene of action. The request for estimating should stimulate their interest in the problems of the business and in the necessity for deriving profit from each unit territory.

2. Market research may yield estimates of the share of potential business available in the individual territories. This is primarily a study of economic geography for the purpose of adjusting the balance and emphasis of sales effort.

3. Forecasting analysis can reveal the effect of general business

fluctuations upon prospective sales. Here, the attempt is to anticipate future industrial trends and shifts in current demand that may affect the production program and the assortment of the output.

The second and third methods supplement each other. What one lacks, the other fairly well supplies. Market analysis cannot usually be brought closely up to date, but this is not essential. The geography of distribution does not change rapidly, and such analyses are valuable for revealing whether a territory can possibly yield enough good accounts to warrant the full effort of a salesman. If it can, then the salesman can be urged to better his performance. If it cannot, then steps can be taken to realign territories to provide better utilization of salesmen's time, possibly releasing other salesmen for closer concentration upon large potential areas that can yield more accounts than were previously being solicited. Contrariwise, forecasting studies cannot be extended in detail territorially, but here greatest advantages are to be gained through anticipating the shifts of demand upon the several groups of product. Ordinarily all product volumes are increased in even proportions. Yet, if one line of product is not keeping up to the average trend, this is likely to be true in all territories due to an economic cause common to all. Moreover, forecasting analysis usually brings to light those general economic conditions that lead to important price changes.

Recognizing that the most uncertain variable is sales, and that salesmen's estimates, originated close to the scene of action, may need revision in view of the broader perspective gained through research, it will be admitted that neither the salesmen's viewpoint nor the conclusions from research should be wholly ignored. To harmonize all viewpoints, sales standards suitable to the particular industry should be worked out for the administrator, so that he may know, for instance, that "territory 4 is operating at only 75 per cent of possible available business"; or again, that "brass goods are not as far above normal as they ought to be in view of the business boom that has developed generally." Needless to say, the best forward estimates of sales and the greatest actual increase in sales will result if the findings of research are used to convince salesmen that their territories merit study and can yield a more profitable volume.

The Production Budget. When the sales budget and the probable assortment have been estimated, it is but a step to translate these schedules into work quantities for various departments. For this purpose conversion ratios are developed. For instance, in the valve and fittings industry it will be known that a ton of iron valves will require definite proportions of cast iron, brass and other metals. Hence, a commodity purchase schedule can be made up and inventory control

limits developed. Similarly, factors are calculated to reveal the number of work hours required to cast, machine, assemble and test various products. These production ratios will all be on a per-ton basis in order that the sales-tonnage estimates may be translated into operating factors. Many of these standards are standards local to the production department [1] and the administrator simply needs to know that they exist and that they are kept up to date. However, for himself, the administrator will need an over-all measure of individual works efficiencies, and one of the most useful factors for this purpose is a continuous

PRODUCTION ESTIMATE SCHEDULE

PRODUCT CLASS	ESTIMATES BY TONS	ORDERS				INVENTORY			PRODUCTION			FOR COMPARISON				
		EXCESS UNFILLED ORDERS	1st QUAR.	2nd QUAR.	COMB. QUARS.	PREDICTED AMOUNT 1/1/28	DESIRED 7/1/28 ATHT OF INV.	DESIRED 7/1/28 AMT. OF CHANGE	1st & 2nd QUARS. TOTAL	1st & 2nd QUARS. AVE.	COMMITTEE'S AUTHORITY PRODUCTION	ORDERS 3rd QUAR.	ORDERS 4th QUAR.	ORDERS YEAR'S TOTAL	PREVIOUS PROD. QUOTA	NORMAL STANDARDS
		A	B	C	D	E	F	G	H	K	L	M	N	P	Q	R
					A+B+C			F-E	D+G	H÷2						
X	PLANNING	0	435	480	915	400	375	-25	890	445		480	405	1800		BUDGET ORDER RATE= 450
	SALES	"	400	480	880	"	400	0	880	440	440				470	BUDGET STOCK LEVEL= 400
	PROD.	"	375	450	825	"	375	-25	800	400						NORMAL RATED CAPACITY = 500
Y	PLANNING	0	375	360	735	255	300	+45	780	390		385	360	1480		BUDGET ORDER RATE= 000
	SALES	"	350	350	700	"	330	+75	775	388	390				410	BUDGET STOCK LEVEL= 000
	PROD.	"	375	390	765	"	300	+45	810	405						NORMAL RATED CAPACITY = 000

FIG. 17. QUARTERLY PRODUCTION SCHEDULE BASED ON SALES FORECASTS

record of each work's "output per man hour" adjusted for variations in assortment.

Quite aside from detail production factors there is the matter of administrative policy with reference to the sequence of production and this policy in itself represents a standard against which to plan future operations. Figure 17 shows how quarterly sales estimates are converted into quarterly production allotments that are in line with administrative standards relating to production sequence. The data on the schedule usually include estimates of orders for a full twelve months ahead, and such lengthy estimates serve as background material for fixing the production rate, even though the specific calculations

[1] Cf. Chapter XV.

in columns A to K relate to but a six-month span. Several interested executives enter their respective estimates in columns A to K, but the committee's authorization entered in column L is not a complete calculation inasmuch as it may be freely affected by judgment. We attempt always to gain constant adjustment to an averaged rate of production, often preferring to finance increased stocks prior to an expected peak of demand, rather than to fire and rehire our trained workers. The most expensive ingredients in our business today are trained labor and effective organization. The least expensive ingredient, judged by effective results, is the interest charge on just enough additional stocks to guarantee customer service and to build up goodwill. With us, it is good business to aim for the economies of steady production.

In the process of arriving at a wise judgment on each class of product, it is of inestimable value for the administrative staff to consider the "normal" standards that show upon the table. The "budget order rate" set for each group represents the normal or average level anticipated according to the original annual budget for the year. The "budget stock level" represents the "number of months' stock" that should be carried on hand on the average to give good service at the standard rate of orders. The "normal rated capacity" standard represents the maximum productive output that might be attained under normal conditions and without working overtime. Naturally, this can be exceeded for short periods but could not be exceeded continuously without possibility of developing excessive costs. The policy of establishing approximately even production allotments each quarter is itself an administrative standard, but these "normals" for each product class of each separate works are subsidiary standards that facilitate execution of broader standard policy.

Ratios of Inventories to Sales. Most businesses are complex. While there are ways of devising simplicity for the purposes of conception of all activities, through the organization of personnel and the classification of product and expenditures, the fact remains that in its details a business is complex. Work orders must be entered into the shop for definite quantities of certain items requiring specific processing. Each order requires individual decision. The administrator must know that control devices are established to give effect to general policies. Roughly, there are three classes of product items: the fast movers, the slow movers, and the specials. In a typical business, as few as 600 out of 23,000 items may comprise 67 per cent of the total volume. On the other hand, the 22,000 slow movers may all be necessary items required for prompt delivery against certain customers'

needs. Ordinarily any factory must accept a certain amount of its volume in the form of orders for special goods.

The policy of inventory control depends upon balance-of-stores-card operation, where the maxima and minima are determined according to whether the item is a fast or a slow mover. The maxima and minima for the fast-moving items can be set according to the usual formula. In the case of the slow-moving items the usual formula can be developed as a starting point, but three other factors must be considered: whether "quantity to order" is large enough to make an economical run; whether it is preferable to produce less than the economical run even if costs run higher; and whether the annual volume of orders may result from erratic buying in which all of the annual total may have been called for upon one or two single orders, in which case the "minimum stock on hand" might have little relation to either the replenishment period or the economical run.

In a preceding section we discussed the policy of producing for steady employment of the force, letting inventory absorb the variations in demand rather than plant operation. This means that at certain times work orders may be entered into process quite regardless of current replenishment, and it is often a wise policy under such conditions to produce a wide assortment of the fast movers in advance in order to keep the shop busy. This policy will tend to build inventories temporarily out of relation to sales volumes, but develops the distinct advantage that shortages on slow-moving items—shortages that can not well be anticipated before the rush of demand develops—can be noted and work orders can be entered as "special rush" while the spurt of demand continues. If the boom were not forseen and if, as a consequence, the grand total of all production had to be speeded up in parallel, then it would be too late to give proper service on the special replenishment orders necessary to make reasonably prompt shipment on the slow movers.

Ratios of Costs to Sales. It is essential to the administrator in any business to know the elemental costs that make up the total charges against income from sales. For simplicity of conception these costs must be upon a unit basis; that is to say, we must know how many cents out of each sales dollar will be expended for direct material, for direct labor, for indirect labor and for the several types of overhead. In fact this unit cost breakdown should be available for each of the several groups of product in case the line is too diversified to figure unit costs for each separate product. Analysis of the costs for the several groups will of course reveal that some run to a higher price basis than others. Ordinarily a distinction will be made between total costs and shop costs in order to satisfy two requirements of the admin-

CLASS 011 VITAL STATISTICS

KEWANEE WORKS TONNAGE

PLANNING AND STATISTICS SECTION — YEAR, 1924

Line	Formula			FIRST QUARTER Jan.	Feb.	Mar.	Total	Ave.	SECOND QUARTER Apr.	May	June	Total	Ave.	THIRD QUARTER July	Aug.	Sept.	Total	Ave.	FOURTH QUARTER Oct.	Nov.	Dec.	Total	Ave.	YEAR Total	Ave.
																				(c)	(c)	(c)			
1		Incoming Orders	Gross	193	162	119	474	158	107	73	79	259	86	91	88	98	277	92	128	122	(177)	(427)	(142)	(1437)	(120)
2			Inter.-Plant	43	12	10	65	22	14	6	3	23	8	4	4	4	12	4	10	9	(9)	(28)	(9)	(128)	(11)
3	1 – 2		Real	150	150	109	409	136	93	67	76	236	78	87	84	94	265	88	118	113	(168)	(399)	(133)	(1309)	(109)
4		Unfilled Orders 1st of Mo.	Gross	100	128	132		120	90	75	52		72	48	53	57		53	44	41	65		50		74
5			Inter.-Plant	10	38	27			9	8	5			5	5	6			4	4	7				
6	4 – 5		Real	90	90	105			81	67	47			43	48	51			40	37	58				
7	1 + 4	Total Gross Orders Fund		293	290	251			197	148	131			139	141	155			168	163	(242)				
8		Shipments	Gross	164	155	157	476	159	121	95	83	299	100	86	81	110	277	92	131	98	(114)	(343)	(114)	(1395)	(116)
9			Inter.-Plant	14	20	25			16	10	4			4	5	2			11	7	(8)				
10	8 – 9		Real	150	135	132			105	85	79			82	76	108			120	91	(106)				
11		Additions	Production	128	139	152	419	140	141	122	107	370	123	74	62	92	228	76	112	111	(130)	(353)	(117)	(1370)	(114)
12			Purchases	10	8	2	20	6	2	1	1	4	1	2	2	2	6	2	1	2	(5)	(8)	(3)	(38)	(3)
13	11 + 12		Combined	138	147	154	439	146	143	123	108	374	124	76	64	94	234	78	113	113	(135)	(361)	(120)	(1408)	(117)
14		Inventories (End of Mo.)	Total	526	502	506		512	499	511	549		520	551	574	562		562	551	563	(575)		(563)		(539)
15			Fin. Stock	336	328	325		330	347	375	400		374	390	373	357		373	339	354	(375)		(356)		(358)
16	14 – 15		W. in Proc.(d)	190	174	181		182	152	136	149		146	161	201	205		189	212	209	(200)		(207)		(181)

NOTE—a Difference between Gross Orders and Gross Shipments equals amount of change in Gross Unfilled Orders, (except as affected by occasional cancellations).
b Difference between Combined Additions and Gross Shipments equals amount of change in finished stock inventories.
c Amounts in parentheses are estimated.
d Work in Process is difference between "Total" and "Finished Stock" Inventories. Therefore it includes all parts-in-process as well as assemblies-in-process.
● The record is reproduced as of December 20, 1924.

FIG. 18. A FORM OF RECORD FOR ACCUMULATING FUNDAMENTAL STATISTICS FROM WHICH SUMMARIES ARE PREPARED

istration. Naturally, from one angle, the sales department will be interested in comparing grand total of all costs against the net income got from customers. The difference between the two will represent the contribution of the sales to the net profit of the company.

On the other hand, the administrator is also interested in considering the amount that a certain product group may contribute toward the grand total fund available to pay all overhead factors. It is conceivable that the percentage margin of difference between total of all costs and the selling price may be the same on one product as on another. Let us say that the sales price mark-up over shop costs (which includes only the costs of direct material and labor that attach to and are identified with each unit of product) may be no greater on each product than the average mark-up. And yet it is possible that one of these two products may be the more valuable from the standpoint of contribution of income out of which to pay overhead. If, with only the average per cent mark-up, the sales of one product are in good volume and run to a high-price level per unit, then the "no more than average" mark-up percentage will really represent many more dollars of income over shop costs; and these greater dollars per unit will be contributed from a greater volume of units, so that the group may make a large contribution to the total income which must be got from some source to pay for the general overhead. The value of unit cost calculations upon the two bases of total and shop cost, for comparison against unit sales prices, cannot be overstressed as an administrative tool.

The Expense Budget. Probably no phase of administrative control needs more constant personal attention on the part of the administrator than the coordination of expenditures for indirect and overhead expenses that are not "automatically" tied directly to such volume of product as may be undergoing the fabricating process. To gain control over these controllable expense items the administrator adopts three devices. In all three of these methods, stimulus is gained by comparing performances in one department with performances in other related departments.

1. For each unit or department having a distinct entity with a responsible manager, the amount of expense is first classified broadly and then broken down into greater detail.

2. Relative standards are developed so as to judge expense upon such bases as per-ton, per $100,000-of-sales, percentage to sales, or percentage to gross profit.

3. An alignment of expenses is made relative to a reasonably normal standard of distribution.

Supplementing these periodic analyses, special studies will be warranted. Ordinarily any expense item or a small group of expense

items can be directly related to some relevant "volume" factor in order to determine a unit measure. For instance, clerical payroll will not necessarily be properly represented when measured in percentage of sales, but it has a fairly direct relation to the number of sheets of paper handled in the clerical process. Hence, a per-order or per-invoice basis will serve as a suitable yardstick for making comparisons between units. Since payroll normally is the heaviest single item in overhead burden, it is worthy of close scrutiny, and a summary classification of employees by grades of income will analyze it from another angle and a suitable "standard distribution" can be developed against which to check the several individual units. For instance, if normally 60 per cent of the payroll should be comprised of those receiving $100 a month or less, then a policy of excessive liberality is indicated on the part of the manager whose payroll runs to only 40 per cent for those receiving $100 or less. Certain it is that the administrator knows he cannot pay out of pocket for costs or expenses any more cash than he may get from customers, and if he does not keep expenses in line with income the penalty will be reduced earnings and eventually reduced capacity for production.

Various Income Ratios. In recent years greater attention has been directed toward the study of income-statement ratios. These include the ratios of sales to total assets, of merchandise inventories to sales volume, of net worth to sales volume, and of earnings to total assets. The ratio of sales to total assets shows the vitality or activity of fixed assets. The ratio of inventory to sales measures the size and effectiveness of the inventory. The ratio of net worth to sales reflects the activity of the stockholders' investments. The ratio of earnings to assets is the most direct standard by which an outsider can judge the effectiveness of the administrator's efforts. The stock market will usually set a valuation upon the company's common stock upon the basis of the percentage earned on total invested capital. The administrator naturally wishes to "see himself as others see him," so he watches these standards carefully, and in the budget analysis that comes under his review, he formulates his decisions in such a way that they will tend to turn the ratio trends in the right direction.

Another important income ratio is that of reserves to total assets. While this is not strictly an income ratio, it reflects the disposition of income. As each year progresses, there should be a deduction from current income and an addition to total reserves against assets to care for their depreciation. The proportion added to reserves each year indicates the degree of conservatism with which profits are calculated. Similarly, one would watch for a measure of the disposition of net profits. In most industries it is considered good practice to

allow for reinvesting in the business approximately one-half of the year's earnings. It is not considered good policy for profits to be largely disbursed to stockholders without rehabilitating the plant and equipment to assure that it will be up to date and in line with competitor's facilities.

Study of these income ratios can be most useful when the administrator has learned the normal ratios for his industry. Gradually ratio experiences are being tabulated and classified according to individual industries. There have been found to be great and justifiable differences between one industry and another, and extension of the ratio analysis so as to discover the average of such ratios for competing companies in the same industry should yield the administrator a fair standard by which to judge the position of his own company.

Ratios of Accounts to Sales. More and more administrators are applying to sales operations the same type of scientific analysis that was previously pursued only in connection with production activities. Just as it was formerly appreciated that certain machines were best adapted to certain types of fabricating and that other machines were adapted to other types, so analysis is beginning to discover that there are material differences in the values of territories, of salesmen and of customers. One type of customer must be approached after one fashion and another type of customer should be solicited in an entirely different manner. The significance of these observations becomes clear when we understand that in some industries sixty customers out of 4,000 may give as much as 70 per cent of the total volume of sales; whereas, at the other end of the scale, half of the number of customers may give less than 5 per cent of the volume. In the case of one large producer, studies have indicated that any account less than $600 a year cannot be handled except as a loss, and that nearly half of the accounts have been of this size or smaller. In another typical case, where a manufacturer was conducting national advertising at a tremendous cost, it was discovered that less than one hundred individual companies were large enough to utilize the product advertised.

With the integration of business enterprises that has been developing and seems destined to continue, it becomes more and more important to classify the types and sizes of customers, to discover how many customers of one type and size can be handled by a given type of salesmen, and how many customers of another type and size can be handled by another type of salesman. Moreover, the selling-expense ratio in the case of salesmen selling to one type of customer may be not at all comparable with the selling-expense ratio justifiable in selling another type of customer. Similarly the average-per-customer sales figures show such extremes that sales summaries may become distorted if they

ANALYSIS OF ACTUAL VS. ESTIMATED NET PROFITS

MARCH 1929 TO DATE

(Comparisons with 1929 Annual Budget Data)

	OVER-ALL NET PROFIT			PROFITS GAINED OR **Lost** DUE TO MARGIN WIDER OR **Narrower** THAN EXPECTED		PROFITS GAINED OR **Lost** ON PORTION OF SALES VOLUME GREATER OR **Less** THAN EXPECTED		SAVINGS GAINED OR **Lost** DUE EXPENSES LESS OR **More** THAN EXPECTED	
	Original 1929 Budget Expectation	Auditor's Actual Report	Over or **Under** Expectation	Out of Stock	Direct	Out of Stock	Direct	Variable	Fixed
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*K*
January Grand Total									
February Grand Total									
March Grand Total									
To-Date Grand Total									
Total Works									
Total Branches									
Total Divisions									
Total Subsidiaries									
Total General Office									
X Works	$35,200	$47,600	$12,400	$10,600	.....	$1,300	.....	$ 700	**$200**
Y Works									
Etc.									
Branch A									
Branch B	$ 8,300	$ 7,900	**$ 400**	$ 1,500	$600	**$ 800**	$300	**$2,300**	$300
Branch C									
Etc.									
Etc.									

FIG. 19. COMPARISON OF ACTUAL WITH ESTIMATED NET PROFITS

do not make some recognition of customer types. In one case it was found that the total sales declined 30 per cent from the first quarter of one year to the fourth quarter of the same year. But if only nine of the large customers were omitted, it was found that the balance of sales volume had been continually increasing throughout the year.

Ratios of Collections to Accounts. Two ratios are found helpful here. In one sense they both measure the same thing but in reality reveal two separate aspects. First, there is the factor of the "number of days' sales uncollected." In this case the amount of all kinds of "receivables" on hand at the end of the "terms-of-payment period" are divided by the daily rate of sales during the period. This gives a figure showing the "number of days' sales tied up" and uncollected in cash. If the figure increases, it means that more investment is being put into financing the sales, tending to increase costs and decrease profits as well as to make for a less liquid financial position.

The second ratio develops the amount of a "collectables fund," thereupon finding the ratio of cash collections to the "collectables fund." In figuring the "collectables fund" account must also be taken of the terms of payment. During any month cash collections may be made from any account that was included within any of the "receivables" at the first of the month. If cash discounting is permitted, it is possible that cash collections may also be made during the month from any of the sales made in the first fifteen days of that month. Hence the "collectables fund" provides a rational measure of the effectiveness of credit policies. In this case, the measure of improving performance is an increasing ratio. This contrasts with the other method of measurement whereby improving performance would decrease the "number of days' sales uncollected."

A third vital factor that the administrator watches in checking up on credit performance is quite independent of current collections. This factor compares the loss from bad debts against the total amount of sales. This factor varies with industries, in some industries falling as low as one-fourth of one per cent of bad debts and in others running as high as 2 per cent of sales. Needless to say, the administrator expects this ratio of bad debts to sales to be kept at a minimum.

Ratio of Profits to Sales. Net profits are a summary of all the variables affecting the business. If profits decline, we blame competition. If they increase, we attribute it to our wise direction. As a matter of fact, profits are as often contributed by fortuitous circumstances as losses are occasioned by conditions beyond the individual administrator's control. Speaking generally, it is the competitive market situation that fixes the selling price, but the competitive situa-

tion does not restrict an individual administrator in any attempt toward reduction of cost or elimination of unnecessary expense.

There is in every industry the marginal producer whose volume of product is necessary to satisfy the grand total of demand, but whose costs are so high that he could not continue to produce unless the price is maintained high enough to keep him in business. If prices declined, this producer would close down. The market, being short of his product, would bid average prices up enough to cover his costs and keep him going. In the long run this marginal producer fixes the industry's price level. In this sense, then, any administrator may consider the market price level as fixing the standard of income within which he must operate at less than the marginal producer's cost if he is to make a net profit. The plank is narrow and he must walk carefully. He must get volume to reduce costs. Yet he must not permit sales effort to reach into those marginal territories where distribution costs begin to eat up the profits, where sales effort meets disproportionate sales resistance, or where bad-debt losses on poor-credit risks wipe out gains on the good accounts.

We have purposely said that it is in the long run that the marginal producer fixes market prices. Actually volume and prices are undergoing constant variation. At a given moment of time one cannot be certain just what the price level is going to be, and consequently cannot tell just how far he should go in reaching for the increasing volume that is so necessary to secure volume production and decreased costs. Every administrator faces a dilemma and it is only by keen foresight and shrewd judgment that he may throw the balance toward profit rather than loss. If he can somehow get enough extra volume from marginal customers without added excessive expense, and if he can devise economies and effectiveness of production without sacrificing competitive quality, then he will find his reward in a margin of profit left after paying all costs and expenses out of the income gained from sales. In this sense, then, the competitive market situation itself, and the ability to get a net profit in spite of it, become the final standards by which the administrator may judge the effectiveness of his own administration.

Various Balance Sheet Ratios. Probably the most familiar ratio comparison derived from balance sheets is the ratio of current assets to current liabilities. This ratio reveals the liquidity of the enterprise and in most cases it is considered that the ratio of current assets to current liabilities should be two to one. However, this factor varies as between industries. In certain industries the ratio may well run as high as four or five to one. Probably next in importance is the ratio relating to cash position; namely, the ratio of cash to current liabilities.

The administrator must watch this closely also to determine the practicability of caring for interest and dividend obligations as well as for current commitments.

It is good practice to liquidate all current notes at least once a year. Current borrowings usually are availed of to care for seasonal requirements. By their seasonal nature they are temporary, and three-month or six-month notes usually suffice. With the passing of seasonal requirements these notes should normally be liquidated at their maturity. This general liquidation will occur during an annual "house cleaning" of inventories and of seasonal accounts. Hence, the ratio of current notes to total working capital, when watched continuously through the year, becomes a measure of the effectiveness of the administrator's control over the seasonal variations of his business. Naturally, the inclusion of current notes with current liabilities, and the additions to inventory or receivables that may result from the expenditure of funds derived from current borrowings, may seasonally distort the ratio of current assets to current liabilities. But it is presumed that the administrator is watching all of the various factors and ratios described, and that the various effects upon the several ratios all explain one another if a definite, clear-cut budgetary program has been laid out in advance and is checked up continuously as time progresses.

In contrast with the varying nature of the foregoing two balance-sheet ratios, there are two others that are fairly stable in character, yet are significant for the administrator to watch in appraising the effectiveness of his policies. One of these is the ratio of debt to net worth. The other is the ratio of surplus to total capitalization. The former ratio represents the relation between the money interest of creditors and that of stockholders. Obviously, a business cannot become too heavily involved without jeopardizing the safety of common-stockholders' interest. Moreover, interest payments on that portion of total capitalization that is represented by debt constitutes a prior lien on profit earnings, payment of interest on debt usually being required at due dates regardless of possible unfortunate developments which may prove tragic even though temporary. The other ratio, that of surplus to total capitalization, reflects the opposite aspect of the picture; namely, the relative security of the common-stockholders' equity. As the proportion of undistributed surplus increases and as the proportion of debt recedes, there is an increased guarantee of continuity for the management and maximum assurance of profit return to the real owners of the business.

Significance of Administrative Standards in the Philosophy of Scientific Management. In all of this discussion concerning the most important detailed factors that greatly aid the administrator in the

specific phase of his task, we have not lost sight of the fact that the policy of operating a budget is itself the primary standard. The budget is the administrator's device for measuring those elements in his primary problems which will subject themselves to quantitative measurement. By no means is it to be thought that budgeting secures an automatic administrative control. The budget process is in reality simply a sort of machine, and no more can be gotten out of one end of the machine than is put in, in the form of material and effort, at the other end of the machine. Moreover, many problems cannot be brought within the scope of budget technique, and therefore the budget can be only one of several important instruments that aid in solving administrative problems.

In these days of high standards in jurisprudence, in medicine and engineering, in fact in each one of the exact sciences, the successful enterpriser must be equipped with a fund of hard-earned knowledge and a chest of nicely designed instruments. So will the skilled administrator soon be required to display a record of arduous research and an ability to handle a set of well-sharpened tools before he can qualify for a master job. In the uppermost compartment of his kit, within easy reach, will be found a tool marked "Company Budget." It will be well oiled and smoothly polished.

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CHAPTER XII

MERCHANDISING STANDARDS[1]

MERCHANDISING is the coordinating force between the task of selling goods and the task of buying or manufacturing the goods to be sold. It establishes standards of proper construction, proper varieties, proper quantities and of prices best suited to the market.

This task of merchandising consists of four elements:

I. Research into the value and uses of goods, resulting in
   1. Progressively better adaptation of the merchandise to its uses
   2. The discovery and development of new uses
   3. The development of new goods
   4. The withdrawal of obsolescent goods

II. Market analysis

III. Coordination of market needs and production or purchase facilities, which involves
   1. Design, origination and selection of products
   2. Pricing
      a. Stock merchandise
      b. Special items of merchandise
   3. Manufacturing schedules
      a. Estimating amount of production or purchase necessary to meet the market requirements at different seasons and periods
      b. Estimating probable needs for additional or improved equipment
   4. Selling schedules
      a. Setting master quotas for each type of merchandise

IV. Furnishing to the sales management current facts as to uses and structure of goods so that salesmen may be kept interested and informed.

Making merchandising a distinct function is justified by the fact that the merchandise considered by itself is a factor of paramount importance not only in the management of separate industries and companies but also in the total situation of the country as a whole. Merchandising is too important a function to be regarded as an incidental activity of selling, manufacturing or even general management.

[1] By John S. Keir, Economist, and Henry S. Dennison, President, The Dennison Manufacturing Company, Framingham, Mass.

For example, the year 1908 seemed to see the saturation point in this country for heavy, high-priced automobiles of individual designs, a situation which the Ford Motor Company capitalized when it produced its standardized light and cheap model T. In 1925 or thereabouts the saturation point for completely standardized light and cheap cars seemed to be reached and hence the newer models began to show variations in color, design and mechanical equipment. The companies which studied their merchandise and synchronized it with the market changes have profited and given steady employment to their workers. When companies have subordinated their merchandising, they have risked hitting lean periods or absolute failure.

A notable case of crucial merchandising was the work of the Victor Talking Machine Company when the sweep of radio installations in private homes threatened its business. Failure to place proper emphasis upon merchandising has been fatal in many cases. Many striking examples can be found in the machine tool industry in which, both abroad and in the United States, original makers, by failure to study the needs of their markets, lost businesses which had become well established, with names of considerable value.

Research Into the Value of and Uses of Goods. The first specific phase of the merchandising function is concerned with improving merchandise, finding new uses for old merchandise, creating new merchandise, and watching the trends of the market to avoid the retaining of items that give indication of becoming obsolete.

1. *Adaptation.* The first question the merchandiser asks himself is whether the commodities which make up any given line of merchandise are closely adapted to their markets in appearance and design, and in fitness for the uses to which they are to be put. These are fundamental questions underlying most of the other merchandise questions. To be adapted to their present almost universal use, automobiles must be nearly fool-proof in their mechanism, and, barring some revolutionary change in engineering, tend to become practically standardized in basic parts. At such a stage the automobile manufacturer can afford to spend many dollars on studying appearance and design of his product to every dollar that he can afford to spend on improving the car mechanically.

In considering standards of appearance and design, it must be remembered that it is what the ultimate consumer thinks that really counts. There have been cases where a management and its retail dealers have been very enthusiastic over new designs in an established line of merchandise, only to find that to the ultimate consumer these designs made slight appeal. Newness is sometimes newness only in

point of comparison with the old items in the line, but not from the point of view of the trend of the market as a whole. However difficult it may be to gather, the merchandiser must find his fundamental data in the needs and tastes and in the mind of the final consumer.

The fitness of the merchandise to the uses to which it is to be put is an old story and yet an ever-recurring one. Sir Josiah Stamp has warned the British manufacturers not to "live on the tradition of always having made the best goods and hold to this in the face of a market that does not want such goods." Among the hardest habits in the world to break are trade habits. For years, for instance, steel manufacturers insisted on having a coke of "silver grey lustre," although it was never demonstrated that this coke, usually the product of the beehive process, was in use any better than by-product coke of a little different color. The fitting of the merchandise to the use sometimes involves the merchandiser in a study of machines and processes which are quite removed from the product itself. Thus the merchandising of paper towels is largely a matter of finding an adequate and useful holder; to furnish the right belting or lubricating oil one must know much about the wide variety of conditions of its uses.

Persistent and scientific study of how automobile tires respond to their usage has resulted in notable progress in the art. Domestic mechanization has resulted from a thorough and long-needed study of homekeeping processes. In even so homely a commodity as canned soup, when studied in terms of its use, it has been found possible to develop a carefully made product which is a valuable addition to the diet of infants.

The merchandise itself is important, and the way it is packed is often equally so. The manufacturer making goods for resale must consider whether the size, type and appearance of the containers used are satisfactory to the jobber, the retailer and the ultimate consumer. It should be remembered that each of these three call for different qualities in the package of the merchandise handled. The jobber cannot handle bulky packages of light and relatively cheap materials at the expense of valuable floor space; the dealers' shelves are not large, and the goods must look attractive on them; at the same time the attention of the ultimate consumer must be attracted by the container, and his needs met by the number of units of merchandise that are within it. The merchandiser must satisfy all three and still give to his manufacturing department a product that it is possible to make and handle with a fair margin of profit.

Illustrative of these points, the following cases from Dennison experience are cited:

Case 1: For the Jobber.

a. The No. 600 star assortment of items was altered so that it would include six numbers and five colors. This enabled the dealer to buy six dozen containing a complete range of sizes and colors instead of his having to buy thirty dozen. As the volume of sale is limited, this puts the assortment within reach of all dealers.

b. The item of ruffled crepe was dropped because it was found that its bulk took up too much of the jobber's space per unit of value.

Case 2: For the Dealer.

a. In the case of bottle labels, prices ranged from fifteen cents to thirty-five cents. The quantities in a box were adjusted so that each could be sold for fifteen cents.

Case 3: For the Consumer.

a. In many items such as glue, postal labels and baggage tags, the design of the package was changed to appeal to the growing color sense of the consumer.

With respect to resale items, appearance of the container has been the theme of much discussion. The present passion for color has forced many a conservative manufacturer into the adoption of packages which in a former day he would have cried down as rank ornamentation. He must avoid the allegation that a handsome covering forgives a spurious product, while meeting to a proper extent the argument that a quality product deserves a quality package. The appearance of the container is important even where the merchandise is not for resale but is used at once by the initial buyer. The advertising value of good packages for utility items is greater than is commonly supposed. To whatever business he may belong, and whatever may be his motivating impulses, the merchandiser cannot escape the packing problem; he must solve it as he may to fit his particular situation.

2. *New Uses.* There can be no let-up in studying the uses to which merchandise may be put, for old habits change and new ones constantly appear. It is only through preplanned merchandising that a manufacturer can span the changes by progressive adaptations in his product. It is significant that shipping tags are no longer called shipping tags but just "tags," since a wide variety of uses other than for shipping have been discovered; and sealing wax is called simply "wax" since it is almost never used for sealing at the present time. The use of yeast in homemade bread has diminished greatly but its new medicinal use has made up the deficiency many times over.

3. *New Goods.* The discovery of new standards of use for old goods affords frequent occasions to consider the addition of new goods. The problem of new items opens up at once many major questions demanding full analysis.

For the manufacturer there are both financial and physical prob-

lems of new equipment or the purchase of goods from some other manufacturer, or various combinations of these two problems. For both merchant and manufacturer there are the questions of the present state of the market, the future probabilities of costs and gross margin, and the likelihood of future increase or decrease in cost. There is the important though usually overlooked question of how much it will cost to sell the new item, for it is seldom true that items can be added to the salesman's list without a real additional cost. There are questions of the relationship of the new item to the line, both with regard to the type of customers and the kind of sales knowledge necessary; and questions of consistency of the new items in grade and quality, for only under special conditions can high-grade and cheaply-made goods be successfully handled together.

4. *Obsolescent Goods.* The merchandiser can well afford periodically an almost equally searching appraisal of items already in the line. It is always easier to rationalize keeping an old item in the line—usually through the old argument of "rounding out the line"—than it is to drop it. A study of a line item by item in terms of units of sale, dollar sales and net profits over a *period* of years usually proves well worth the cost of gathering this information. It is true that some items are merely dormant and are worth reviving. But it is equally true that it is rather pointless to put a lot of effort back of an item or line whose general usefulness has passed.

With the constant change in business conditions, standardization of items or of parts, and the simplification of lines, are processes which must go on almost continuously if they are to be done when and as they should be, and if complete upsets are to be avoided. Not all businesses can adopt the rigid merchandising policy of Heinz, who would not add one to his fifty-seven varieties unless it proved so much superior that he could afford to drop one. Yet there is a deep wisdom underlying this policy by which all kinds of businesses can profit. Not only do individual items, once established in a line, tend to continue to the point where the cost of carrying them on shelves and in catalogs and in price lists is greater than the net gain they yield, but even, without constant and careful watchfulness, to the point of obsolescence. The impersonal objective point of view for the merchandiser, who must regard all elements of cost and risk as well as mere volume of sales, is needed to sense the on-coming of obsolescence. It is probably true that many concerns are fighting a useless battle over items that consumer resistance has long ago decreed were no longer acceptable. All the king's horses and all the king's men cannot revive the use of red flannel underwear in a country where fireplaces have given

way to central heating plants which keep most of the houses warm even in the severest of weather.

Market Analysis. More than ever today, the manufacturer who is making merchandise for resale is faced with the problem of proper outlets for his merchandise. As O. H. Cheney has pointed out [1] there is a great two-way pressure being exerted in distribution: one, the pressure of goods for outlets and the other the pressure of outlets for goods. Sometimes the two pressures compete, sometimes they synchronize. Upon the problems of resale agencies the merchandiser and the sales manager must work jointly. Some of the special problems which present themselves to the merchandiser are these: (1) Should he design a line to be distributed through jobbers; and if so, should the line be unbranded, or should it be branded with the jobber's name? (2) Should he design a line to be distributed through the chain stores on a price basis; and if so, should it be unbranded or should it be branded with the chain store's name? (3) Should he design a very distinctive line to be sold on a quality basis through specialty shops or other dealers?

These questions, of course, involve the interests and demand the knowledge of more officials than the merchandiser alone. But the merchandiser must face them, nevertheless, and make recommendations in regard to them. His market analyses of the demand for and uses of goods will incidentally furnish him a special and important set of facts bearing upon them. No complete and accurate general resale marketing data are yet available although valuable first steps have been taken.[2] The merchandiser must contribute all the facts he can find and compile.

Figures derived from his own organization are many times of greatest value. It is seldom a matter of great expense when recording sales to record also the type of outlet through which the sales take place. (Figure 20.) Monthly comparisons by lines and by outlets, perhaps also by geographic areas, may give valuable early indications of important trends. Analysis of consumers' markets is in a rather more advanced stage. There have been, during the past ten years, many examples of useful analyses both of business consumers and home consumers. The process is frequently laborious and expensive, but the technique has been reasonably well worked out.

[1] Cheney, O. H., "What Can the Wholesaler Do to Survive?" Wholesaler's Conference, Washington, D. C., February, 1928.

[2] Notably the Distribution Censuses of eleven cities compiled by the United States Department of Commerce and published by the United States Chamber of Commerce. The cities are Baltimore, Providence, Kansas City, Chicago, Springfield (Illinois), Fargo, Syracuse, Seattle, Denver, Atlanta and San Francisco.

Coordination of Market Needs and Production or Purchase Facilities. 1. *Design.* The general principles involved here are the same as those discussed in dealing with adaptation under "Research into the Value and Uses of Goods."

2. *Pricing.* The pricing phase of the merchandiser's function has to be thought of in terms of stock merchandise and of special orders. In either case, adequate price control demands a close contact with the market and powers of insight sufficient to distinguish in the majority of cases the sporadic and superficial from the extreme market changes.

SALES BY TRADES BY COMMODITIES — COMMITTEE — 1928 vs. 1927

TRADES	COMMODITY A Class 1 1928	1927	Class 2 1928	1927	COMMODITY B 1928	1927	COMMODITY C 1928	1927	COMMODITY D 1928	1927
Jewelers (W.J.)	1	25	28		1		18	19		2
Paper Houses	36373	38622	1142	585	6874	7466	33657	36879	1168	1601
Stationers (40 B.W.)	4643	4254	58	212	62	123	53112	52202	1659	2474
Dry Goods and Notions	248	144	10	100			15423	14335	540	446
Misc. Whse. Distributors	1711	1667	25	10	7116	5529	109294	88662	2472	2367
Total Whse. Distributors	42976	44697	1260	935	14052	13118	211504	192097	5839	6890
Department Stores	250	490	10	30			29713	35088	24414	24884
General Stores	91	232		15			7071	10815	807	1036
Drug Stores	163	265		5			27050	27850	4687	4553
Chain Stores	3	48					988	1099	284	234
Printers (25P & 40P)	5422	5950	4312	6678	1945	1945	1468	1870	123	34
Stationers (40BR, 30BR, 25BR)	23056	23878	1757	1269	596	748	116788	112269	30459	30916
Misc. Retail Distributors	2350	3430	13	3130	429	221	70077	58441	5457	5905
Total Retail Distributors	31335	34287	6092	11127	2970	2912	253155	267432	66231	67552
Total Distributors	74311	78984	7352	12062	17022	16030	464659	460129	72070	74442
Textiles	3013	3527	6566	6355	541	20				
Clothing Mfgs.	1898	1859	13580	7458	58	47	40	12		
Leather	272	276	764	155	7	5				
Leather Products	785	532	1013	873			193	632		
Rubber Products	11060	4303	3695	14829	227	40	18	59		
Iron & Steel Products	2082	2274	9960	10465	103	92	10	9		
Other Metal Products	143	349	427	1308		2		1204		
Stone, Glass & Clay Products	118	133	1180	1288						
Food & Kindred Products	4357	6596	16732	20904	15	40	3752	858		
Transportation Equipment	1211	1171	1589	1685						
Railroads	104	120	1443	1090			36			
Musical Instruments	5	5	10	15	7	7				
Laundries, Dyers & Clns.	2306	2198	11623	13463	2		24			
Department Stores	653	544	3207	2400	3		819	1222		
Pen & Pencil Mfgs.								90		
Toilet Prep. Mfgs.	77	31	20	121			198	160		4
Confectioners Mfgs.	35	30	25	80	2	5	32	221		
Hotels & Restaurants	90	40	952	958			13	226		
Furniture Mfgs.	455	229	752	523						
Florists			880	807	1		138	8		10
Jewelers	2	7	100				140	49		
Misc. Consumers	10021	11340	41051	48596	517	1035	4344	4764	6	106
Total Consumers	38657	35564	115569	122883	1483	1293	9757	9514	6	120
Retail Stores	8571	4560			525	27	19971	13921	3	10847
GRAND TOTAL	121539	119108	122921	144945	19030	17350	494387	483564	72079	84809

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FIG. 20. ANALYSIS OF SALES BY TRADES AND COMMODITIES

In making base or list prices on stock merchandise, especially where these prices are published and uniform, the most difficult decisions are involved. When new and lowered costs are obtained, there is forced upon the merchandiser the choice of lowering the price, or retaining the savings as extra profits, or improving the merchandise without changing the price. When costs go up, his choice, on the other hand, is raising the price, or accepting the reduced profits or the losses, or reducing the quality of the merchandise.

When his market goes up, he must consider raising the price or holding the price level, thereby gaining additional volume or good-will,

or improving the merchandise and advancing the price. When it goes down, his choice is lowering the price, or holding the price at a loss in volume, or reducing the quality.

In setting prices on special orders, a variety of considerations govern. The down time of expensive equipment may dictate the taking of single orders at or below factory cost. It may be desirable to take an order simply for the psychological effect on a key salesman in a given territory.

Where there are many salesmen and the prices of specials must, where possible, be made in the field, the merchandiser must classify and codify his goods and price their elements. In special goods there arise the difficult questions of quantity prices, of how great a differential there should be between the smallest acceptable order and orders of large size. This differential is affected not only by manufacturing costs but by selling costs as well. Always the state and trend of the market that exists will be the prime consideration that colors all the rest of the elements.

The fixing of prices calls for a balancing of several factors. The sales organization will always be pressing for volume; the merchandiser will be keeping a sharp eye on profits. But the merchandiser can be influenced by neither profit nor volume alone. He must think of them, but he must think also of the total production program—all of which calls for just the sort of balanced weighing which, because of his coordinating position, the merchandiser is especially well able to do.

3. *Manufacturing Schedules.* Estimating the standard amounts of production or purchase necessary to meet the market requirements at different seasons and periods is a very important phase of merchandising. Factory estimates, on the one hand, are naturally always in terms of what are economical production schedules regardless of what the market demands. Salesmen's estimates, on the other hand, tend to be either too optimistic or too pessimistic and are in fact often colored by what the experience with the last two or three customers might have happened to be. The merchandiser is free to study the situation objectively.

In arriving at his estimate, the merchandiser considers three sets of figures: data on general business conditions, data on optimum factory production; and data on the sales history of the merchandise in question, with regard to the preceding year, the trends over a period of years, and the indications of the immediate future.

The general data are pretty much concerned with the attempt to determine about where industry is in the business cycle. For the study of the cycle itself, the merchandiser will call upon the services of specialized staff men to guide him in his decision. The behavior of

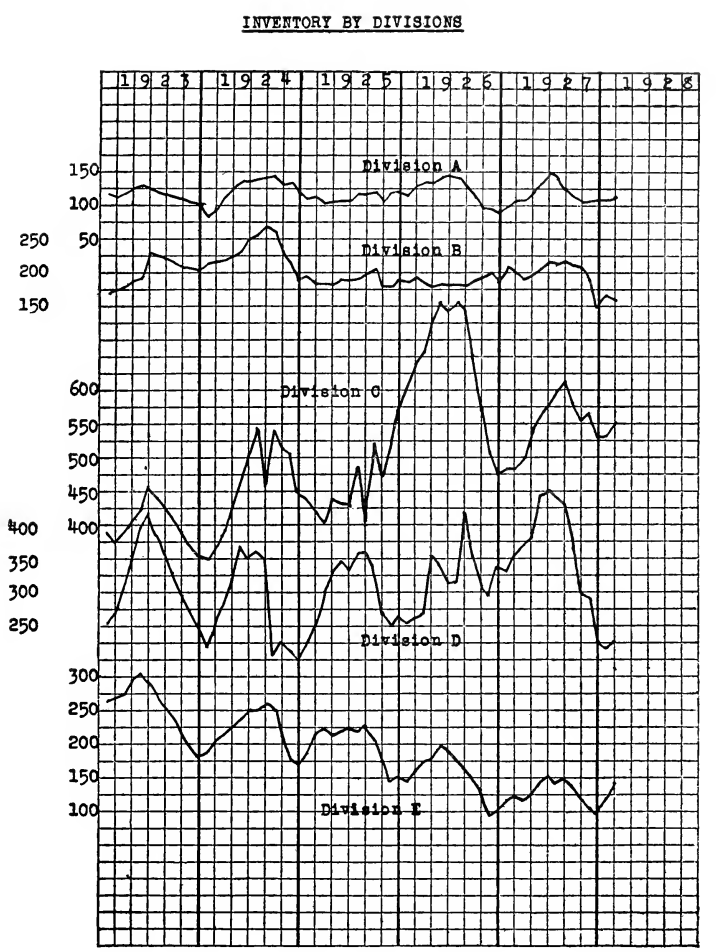

FIG. 21. INVENTORY DATA ARE OF IMPORTANCE IN MAKING MERCHANDISING PLANS

the particular commodity within the cycle, however, is for the merchandiser to estimate. Thinking in terms of a commodity and its relation to the cycle, involves the constant review of how this commodity has acted in times past.

The factory figures considered by the merchandiser in making estimates cover several groups of factors, as, for instance, the number and the types of facilities available for use, inventories on hand, etc. (Figure 21.) He knows, too, the possibility of adapting old facilities for special uses, and that if necessary he may recommend new facilities. The facilities information is the base line of his estimate. It is obviously futile to schedule more than the factory can produce, regardless of what market conditions may be.

Another type of information the merchandiser considers is the flexibility of the producing departments. Some types of work require a high degree of skill and crews must be held together; other types of work are unskilled or semi-skilled and internal transfers can decrease or increase the number required almost at will. Facilities also partake of this range of flexibility, some being more limited than others in overtime possibilities. The degree to which this flexibility factor is present or absent is a guide to the merchandiser in making his estimate.

Sales figures are as fundamental as are factory figures. It would be futile to schedule production for which the figures of past years indicate there can be no adequate market. There is a flexibility factor here as well, for up to a certain point additional sales pressures will yield additional sales. The merchandiser must make some estimate of the cost of this additional pressure as against the net value of the resulting sales.

In most cases, schedules must be made for a full year, since only such a long-span estimate can be a sufficient guide for recommendations as to equipment. But annual schedules are too long and inexact to meet manufacturing or purchasing needs. For these, monthly schedules for the succeeding three months are most often used.

Visual aids in making and in using schedules are of considerable value. The accompanying chart (Figure 22) shows a typical estimate of the Dennison Manufacturing Company. The methods of checking this estimate are also shown.

4. *Sales Schedules.* Final and complete scheduling, which has taken into account the needs and pressures of the market and the advisabilities of adding to or shutting down equipment, is a master operating plan for the whole company. It must seek to lay out the optimum course between allowing machines to be run in an overproducing market and meeting the losses of skilled help, market prestige and of money caused by restricting production; it must try to plan the middle course

between expensive, high-pressure selling and expensive saving of effort. In making this master schedule, the merchandiser will have called upon the full abilities of the buyer or manufacturer and the sales manager, but will himself have used ingenuity in adaptation of goods, and skill in pricing, as well as thoughtful, analytical judgment in balancing all the factors of which he must take account.

Furnishing to the Sales Management Current Facts Concerning the Uses and Structure of Goods So that Salesmen May Be Kept Interested and Informed. The merchandiser cannot rely

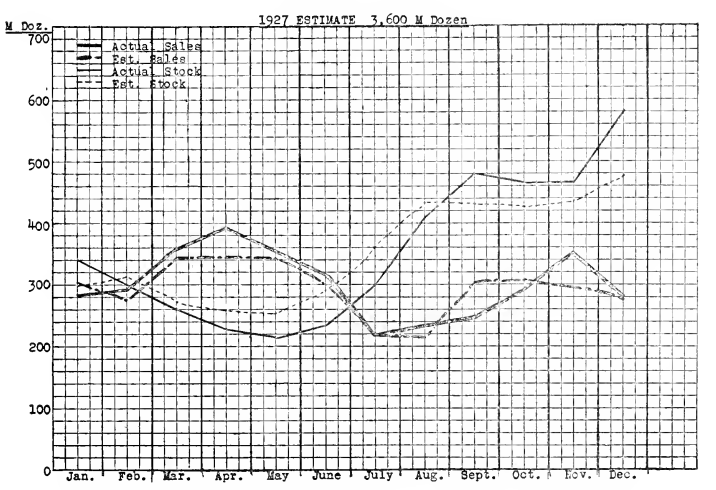

FIG. 22. GRAPHICAL COMPARISON OF ACTUAL SALES WITH ESTIMATED SALES AND STOCK

upon the merchandise to sell itself and he cannot flatter himself that the merchandise is "right." He must always be watching for chances for bettering it and for increasing the ability of the sales department to sell it. He must therefore always be thinking of devices that will make his line of continuing interest to the sales force. He will visit the field and special prospects with salesmen; through such visits and through letters and news sheets he will furnish to the sales department the most usable information as to the qualities and use of the goods. In salesmen's training courses he should be best able to give special "high school" instruction in the merchandise.

In essence, the principle of merchandising is the principle of master

planning the operations of the entire business. It was found some time ago that all things do not "just happen" in business, even in those parts of business which a former day looked upon as belonging to the Goddess of Chance. It is perfectly logical to expect that, as the unknown variables become less both in number and extent, planning can reach more and more deeply into the fields of business activity.

In the history of the professions there is a noticeable trend from generalization to specialization and then to coordination of the specialists. Thus years ago the field of engineering consisted of only one branch. In time, civil engineers were separated from the main branch purely as a matter of convenience to distinguish the activities of surveyors in civil life from the activities of surveyors who are part of the military. And the industrial revolution and later the recognition of the line and staff principle as applied to the factory system, broke up the engineering profession into almost as many units of specialization as there are staff functions to be performed. Later still the term "engineering" has come to have the wider application to any part of industry which is a piece of specialized practice, regardless of whether it be a purely staff operation or not.

Management is today repeating the essentials of this history of engineering. Out of the special functions that have evolved in the general field of management, there is to be recognized one as standing as a coordinating force between the job of selling goods and of manufacturing or purchasing the goods to be sold. This we call merchandising. Merchandising is truly a catalytic agent. It not only effects a better coordination but is a positive force toward leadership and progress.

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CHAPTER XIII

SALES OPERATING STANDARDS[1]

As HAS been indicated in the preceding chapter, the merchandiser, consulting with and drawing upon the experience of the sales management, determines standards with respect to the goods to be made, their price bases and the quantities to be produced or purchased. A special task[2] of the sales manager is, then, to determine standards as to:

I. The outlets
   1. Customers to be solicited, and
   2. Terms of sale.
II. The geographic areas most appropriate for
   1. His district managers, and for
   2. Salesmen's routes.
III. The equipment of offices and men
   1. Office records and files
   2. Salesmen's samples and information.
IV. The data needed to determine various costs of selling.
V. The quotas to be set in dollars or goods for
   1. Each district
   2. Each route or salesman.

Outlets. In its broad outlines the question of outlets will have been fixed by those joint studies of sales manager and merchandise manager necessary for the proper determination of the goods to be handled.[3] Within these outlines there will be details for sales management to fill in—relatively simple in the case of specialty articles for use by particular lines of business, highly complex in the case of many goods which may be sold both for use and for resale.

1. *The Customer.* In the choice of outlets for special goods for direct use in business there arise usually the questions of distance and size. The former demand for their solution a balancing of factors of freight rates, travel costs and delivery times with competitor practices and locations. The latter demand estimation of costs of travel, costs of making a sale and costs of order handling, as well as a consideration

[1] By John S. Keir, Economist, and Henry S. Dennison, President, The Dennison Manufacturing Company, Framingham, Mass.

[2] The tasks more strictly assignable to current management and control are set forth in Chapter XX.

[3] See preceding chapter.

of credit conditions among the smaller prospects and competitive pressure among the larger.

The field for resale merchandise presents many more difficult problems. If it is decided to sell through both jobbers and retailers, it is necessary that the jobber shall have sufficient differential to allow him to sell to the small retailer at a profit; yet it is seldom possible to give the jobber a lower price than is enjoyed by the largest retail buyers. Furthermore, it seems almost impossible to define exactly what a jobber is. The Domestic Commerce Division of the United States Department of Commerce defines a wholesaler as follows:

> It is the wholesaler's function to carry a well-selected stock of merchandise, to buy in suitable quantities, to warehouse a reserve stock for retailers within a radius of economical distribution and convenience of service, and to resell in proper units to the retailer as economically as possible.

Other definitions [1] are:

> The Century dictionary defines a wholesaler as one who deals in quantities.
>
> The definition of the Wholesale Paper Dealers Association is: a firm or corporation having in a public warehouse or in his own warehouse a miscellaneous stock of paper articles covering the general needs of the buying public.
>
> A wholesaler is one whose principal business is the handling of goods in large quantities, and owning those goods, and carrying them in stock; as distinguished from a broker or a commission merchant.
>
> A wholesaler is a man, firm, or a corporation that carries a well-selected stock of merchandise, who buys in considerable quantities.
>
> The wholesaler is a glorified warehouseman, accepting full responsibility to both manufacturer and retailer, and selling only to dealers. With his capital and storage in stock, he furnishes production to the manufacturer, relieves him of selling and credit details, and he functions equally well in simplifying buying and financing for the retailer, to whom he is usually a personal friend and adviser, and through whom he makes available to the consumer the choicest products from the far corners of the earth; and he lives wholly out of the economies he effects for others.
>
> One who carries a stock that he sells to retail dealers and does not sell at retail.

The foregoing attempts indicate the absence of standardization in practice. Nevertheless, for the purposes of planning sales, some defining standard must be chosen. The next problem, then, is whether to sell all wholesalers or only a selected few. The type of product will greatly affect the answer, as will also the liability to increase of competition, the fullness of distribution desirable, and the amount of specific selling effort it will require from the jobber. Selling to a few selected wholesalers will make possible more intensive sales effort by each, but

[1] Minutes of the "National Wholesale Conference," Washington, D. C., February 14-15, 1928.

will limit the extent of the market and may force other wholesalers to build up competing lines.

A parallel question in selling special goods is whether to sell all trades or a few particular trades. The factor of safety would indicate that all trades be sold if possible, while considerations of operating economy bear the other way. The final standard must represent a balance of factors, or, in Miss Mary Follett's words, an "integration." [1]

For the retailer himself, the analogous problem concerns a choice of clientele; whether to attempt to sell people of every economic and social group, or to confine to one or a few. In this problem, location is always an important and sometimes a determining factor, to which the choice of goods, the degree of service given, and the range of price must conform. In those cases where location does not strictly limit the possibilities, a clear outlining of relative advantages to be gained in dealing with one group or another may strongly affect the direction of development chosen for the business; and even where location settles the question, these relative advantages are worth bringing to clear understanding so that goods, prices, character of service and other factors may be brought into exact conformity. A clear statement of the situation will result, as in so many other cases, in encouraging definite standards instead of vacillating and inconsistent practices.

An important and fairly recent problem in selling for resale lies in the selection of types of retail outlets. There is a growing number of chain stores of a wide range of types; department stores of which sales hold steadily to a large proportion of the total of retail distribution; mail-order houses and their new retailing establishments; specialty shops of one kind or another; and an enormous number of small retailers, each of whose yearly sales run from $1,000 to $25,000 per year. To these must be added the cases where the manufacturer reaches his market directly through his own stores or by mail or both.

This is a complicated picture, and it is changing in proportions and constitution very rapidly. The place in it which any manufacturer works out for himself will sometimes be clearly indicated by the whole nature of his business, but more often will be speculative, shifting, and hence, to a large degree, opportunist—planned to gain the best possible for today with the least risk to the future.

In such a situation, where adequate knowledge cannot be had, the fullest possible account of the facts must be sought; yet the mistaking of minor changes for real trends must be somehow escaped, and stampedes avoided.

2. *Terms.* While the merchandise management must finally deter-

[1] Follett, Mary P., *Creative Experience,* New York, Longmans, Green & Company, 1924.

mine the base prices of the goods themselves, and the quantity prices that are to be obtained upon special goods sold for direct use, the sales manager must, in consultation with them, settle upon those terms of sale which vary with the type of customer rather than with the goods. The focus of the merchandiser is upon the goods; the focus of the sales manager upon the customer. Hence, the variations upon base prices, which must be made on account of the customer's situation, are the responsibility of the sales manager.

Of course, whenever fields of responsibility are divided with as much nicety as in this case, it is essential that action should be virtually joint action; consultation should be so intimate that the whole problem is worked out rather as one problem than as separate problems. This same policy must, however, run through all of business management. There are overlapping regions everywhere, yet lines of responsibility must be drawn. Hence there is presumed always to be a general management which can see to it that decisions in overlapping regions meet the joint needs and have the benefit of joint wisdom.[1]

Terms of sale include discounts and f. o. b. policies. There are at least six forms which customer-discount practice may take. These six are: (1) cash discount—depending upon payment within specified time limits; (2) trade discount—differentiating among trades on account of their relative importance or their needs for dealing with each other; (3) patronage discount—under which the discount allowed is graded according to the customer's total purchases during the past years; (4) quantity discount for resale goods—which is graded according to amounts purchased in a single order; (5) postdating the bills—the manufacturer assuming the right, after a specified date, of shipping the merchandise when it is ready; (6) profit sharing with customers—a rather limited form under which a certain percentage of the profits are shared with customers, usually on the basis of the total year's purchases.

Each must be analyzed by the sales manager fully as to its actual incidence and as to all of its effects: (1) cash discount, as to the strictness with which its terms can be or cannot be expected to be lived up to; as to its effects upon volume of correspondence and customer goodwill; as to its effects if it comes to be regarded as a trade discount; as to its effects upon customers' payments and thus upon interest charges or credit standing; as to the difference in results between large and small cash discounts; (2) trade discounts, as to their fitness to the ends they are supposed to serve and the sharpness of definition possible among the trades concerned; (3) patronage discounts, as to their relation to trade discounts; the variations of their incidence in small and

[1] Cf. Chapter IV.

in large communities; their fitness to larger customers who buy frequent small lots; (4) quantity discounts, as to the place of "fill-in" orders; their possible effects on overstocking; the real costs of the smaller shipments; (5) postdating, as to its possible results in advance ordering or in over-ordering; as to its credit results; as to possible savings in manufacture or costs in warehousing; (6) customer profit sharing, as to its results in stimulating resale; as to its effects on goodwill; as to the possibilities when profits vary more closely with raw material prices or management methods than with volume.

Merchandise is sold f. o. b. factory and f. o. b. customer. It is also sold f. o. b. warehousing points, district office cities or other arbitrarily chosen areas. The policy adopted usually is dependent upon the geographical location of the producing units. If these are scattered, an f. o. b. policy making everything either f. o. b. factory or f. o. b. customer is difficult in application. Such a policy, too, is costly in freight bills or price concessions, or in the blocking of that possibility of uniform resale prices for the country at large, which is considered by many as sound practice. The only standard that can be applied to the f. o. b. situation is to be sure of the basis of the standard practice used. This sounds simple but is really quite complicated. It is expensive to make changes. A study of the f. o. b. policy as applied to particular commodities in a line, rather than to study the problem as a whole, is one satisfactory procedure.

Geographic Areas. 1. *Sales Areas.* Into what sales areas his department shall be divided is for the sales manager largely a matter of comparative evaluation of territories. If the merchandise is for resale, it is necessary first to compare sales of this merchandise in city areas or in country areas. In one case it was found that over 50 per cent of the sales came from twenty-six cities and a large part of this 50 per cent from a small number of large accounts within these cities. This did not mean that the sections outside of these cities should not be canvassed. It merely threw into prominence the question of whether they were being canvassed by the proper methods.

In the case of merchandise for initial use, the problem of urban versus rural does not enter. The evaluation there is more often in terms of industries or trade. If it seems worth while with a particular product to canvass the automobile industry, direct canvassing must be done wherever the automobile industry happens to be.

In setting sales territories it is important to consider the matter of transportation facilities, which bears both on the question of routing salesmen and the shipments of merchandise. It is costly to have either goods or men travel too far or too many times.

The possibility of securing statistical data for the territories chosen

is another outstanding consideration. The gathering of statistics for many years was confined to the major political divisions of the country. State lines have, however, been broken down into counties in most state statistics, and more recently complete studies are being made of trading areas.[1] On the score of statistics, the limitations placed on scientific districting for any given product are, then, being eliminated.

In evaluation of territory, one set of facts for which the sales manager is constantly looking, is the potential buying powers of given areas. The attempts to measure this power for particular industries have been many. For most industries, since the situation is a compound, the measuring device must also be compounded. Hence, numerous indexes made up of such factors as total population, number of wage earners, number of subscribers to popular magazines, number of income tax payers and number of automobile owners have been employed.[2] But at best such indexes are only a rough guide, which must be used with care and checked by actual experience whenever that is possible.

A valuable guide is always the company's own sales of past years. If it is known what the sales in a town have been over a period of years, and if the normal growth of the company is known, it is possible, with these figures as a base, to compare the sales of any given year in any given area against this base and get a pretty clear picture of what is happening. At least it will indicate the places for intensive investigation to discover further facts.

Attached is a study which the Dennison Manufacturing Company has made of certain items of resale merchandise by towns. These towns have also been grouped by Federal Reserve Bank districts, and then department-store figures are used as a measure of the general retail trade condition within a particular district. The comparisons are extremely illuminating.

2. *Salesmen's Routes.* Besides fixing the larger areas of administrative control, the sales manager must likewise determine the most effective salesmen's routes. In spite of much writing on the subject, very little actual study has been given to it. Objective things such as train schedules have, of course, been improved. But by and large, the route and the individual prospects within the route have been largely left to the salesmen's judgment. Routes too easily become habits rather than matters of analyzed and planned sales procedure.

It is undesirable both for the management and salesmen that this

[1] Such as Philadelphia Market Survey, South Eastern States Survey, United States Department of Commerce, "Retail Trading Areas," J. Walter Thompson Company.

[2] A procedure used by the Dennison Manufacturing Company is described in the *Bulletin of the Taylor Society*, Vol. XII, No. 6, December, 1927.

TABLE 5

FEDERAL RESERVE DISTRICT	Some items of Dennison Resale Merchandise Compared with 1920–24 Base % of Change	Department Stores Sales Compared with 1920–24 Base % of Change
Boston	+ 16	+ 21
New York	+ 31	+ 31
Philadelphia	+ 6	+ 16
Cleveland	+ 7	+ 16
Richmond	− 20	+ 25
Atlanta	+ 15	+ 16
Chicago	+ 21	+ 41
St. Louis	+ 37	not reported
Minneapolis	+ 39	+ 4
Kansas City	+ 45	not reported
Dallas	+ 13	+ 20
San Francisco	+ 20	+ 40

should be so. Routes, whether within a single city or including several cities, are susceptible of analysis. A study of the Dennison Company showed 40 per cent of a salesman's time spent moving between customers—an amount in total which justifies a great deal of experiment directed toward its improvement.

Equipment. The records which are kept as part of selling equipment are of two general classes. These classes are those which are kept by the salesman, and those which are kept for the salesman by the regional sales office.

1. *Records.* The records which are kept by the salesman as part of his equipment are also of two types, those which are used by him as tools in his selling efforts, and those which are kept by him for use at the district or home office for statistical or other purposes. Under the type kept by the salesman as part of his equipment would come such records as sales order forms, credit slips, estimate calls, requests for special service and requests for special aids.

The type of record kept for the salesman at the district or home office would include such things as daily reports of calls and sales, daily reports of expenses, orders lost and orders sold by type of customers, and weekly summary of calls, sales and expenses. (See Figures 23 to 25.)

The class of records which is kept in the regional sales office for the salesmen's use includes records of sales by towns on each sales-

man's route; record of customers as to kind and quantity of goods purchased, as to credit record and as to lists of potential customers, by towns or routes; trade discounts and mailing lists; receipt and disbursement statements; computation (usually monthly) of lost order reports; and computation (by various periods) of sales by individual salesmen, and by the sales region as a whole.

DISTRICT NO. _____ ROUTE NO. _____

Summary of trip of _____

Begun _____ Ended _____ Away _____ days

Date	Towns Visited	Expenses	Sales			
			A	B	C	J
TOTALS,						
GRAND TOTAL,						
Average daily sales and expenses,						
" " living expenses,						
" " " " with Sleeper						
$320.						

FIG. 23. SUMMARY OF SALESMAN'S TRIP REPORTS

2. *Samples and Information.* Adequate samples for salesmen are always a major problem in the general plan of sales equipment. Really to solve it requires a study of the exact uses to which samples are and should be put, with particular attention as to how far the sampling policy should be standard and fixed. In practice it often works out that the sensible thing to do is to build a minimum sample equipment for

each line, salesmen being permitted to call for special samples according to the merchandise they are selling and to the territory they are canvassing.

It pays good dividends to keep a sharp eye upon sampling practice. Samples quickly run into money. It has often proved worth while to control the issuing of samples by making it one of the functions of a

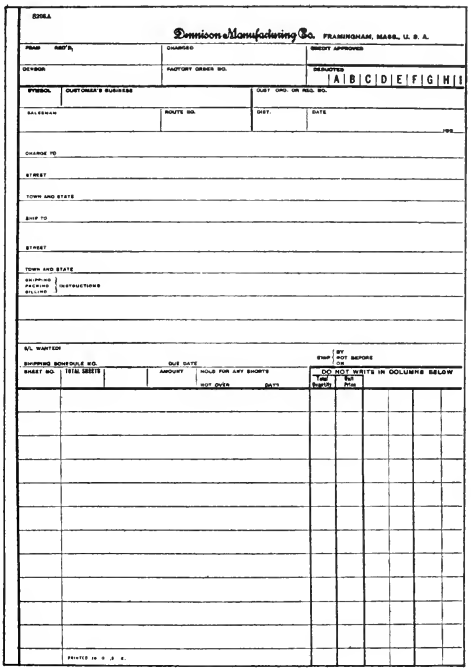
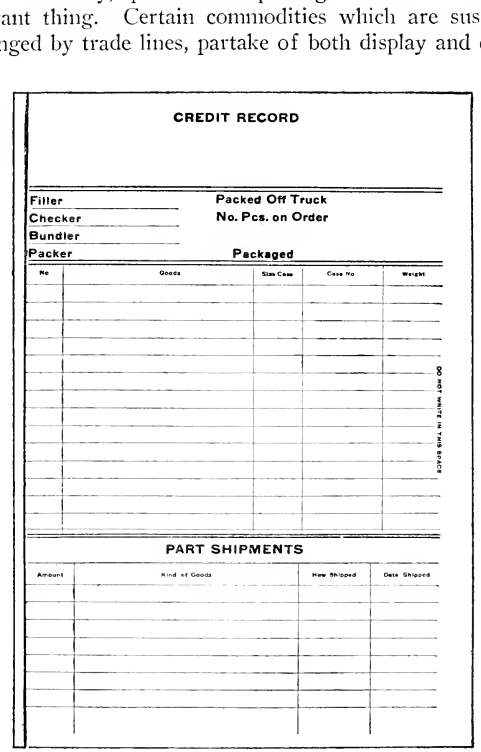


FIG. 24. OBVERSE OF CUSTOMER'S RECORD

major sales executive. It is, of course, good management to have some sort of district or home-office clearing house, through which the salesmen can be kept in touch with ingenious and new designs, or particular combinations of design and construction that have opened new outlets for the merchandise or have been of especial interest to the familiar outlets.

The arrangement of samples for actual use by the salesman will vary

according to whether the samples are part of a display, or are individual commodities. If the samples are part of a display, quickness of getting them before a customer is not important. If the sample is an individual commodity, quickness of putting it before the customer *is* the important thing. Certain commodities which are susceptible of being arranged by trade lines, partake of both display and commodity



CREDIT RECORD

Filler
Checker
Bundler
Packer

Packed Off Truck
No. Pcs. on Order

Packaged

No	Goods	Size Case	Case No	Weight

DO NOT WRITE IN THIS SPACE

PART SHIPMENTS

Amount	Kind of Goods	How Shipped	Date Shipped

FIG. 25. REVERSE OF CUSTOMER'S RECORD

sampling. Both quickness of getting them before the customer and their attractive general lay-out then are important. Another part of sample arrangement is to allow space for the salesman to add to his standard equipment special samples that he feels would be of interest to his particular customers.

Sales information must be continuous and sent through in such form as to be of ready usefulness to the salesmen. The usual media are sales catalogues, manuals, letters and special sales bulletins.

A sales catalogue is encyclopædic; a sales manual is a record of standard practice, while sales letters and special bulletins are news media of an active, going organization. The purpose to be served will dictate the particular form used. Inexperienced salesmen require one type of information and experienced salesmen another, while some types are standard for both. Regional sales executives may be given sales information of a quite different sort from that given the most experienced of the salesmen in the region. But all must have continuous selling information.

Selling Costs. For some time the costs involved in marketing have engaged the attention of students of our economic structure. It is probable that in any one year about half the cost of making merchandise and getting it to the ultimate consumer lies beyond the factory gates. Furthermore, very little attention has been paid to marketing costs, since by and large the past thirty years have been years of rising prices. From the impetus given by Taylor and other engineers, factory management has made a continuous drive on factory costs. Selling costs are about where factory costs were at the time of Taylor's initial work. The need of sales costing is now becoming apparent since a period of falling prices has set in and a buyer's market is the order of the day and seems likely to be for many days to come. Total costs must be examined, as well as factory costs alone, or, indeed, selling costs alone.

Many first studies of selling costs are already under way. The Harvard Bureau of Business Research has completed a series of selling costs on individual trades.[1] Trade associations are making costs of selling a major portion of their lines;[2] and individual trades, such as hardware, have started excellent pioneering work in the field, as has the United States Department of Commerce. But, at best, the sum total of all this effort is only a beginning.

The Dennison Manufacturing Company has kept accurate records of general selling expenses for many years. It has also made studies of such things as the cost of filling small orders and the cost of selling

[1] "Studies on Selling Costs," including the following subjects: Operating Expenses in the Retail Automobile Tire and Accessory Business; Operating Expenses in the Wholesale Automotive Equipment Business; Operating Expenses of Building Material Dealers; Operating Expenses in Department Stores; Operating Accounts for Retail Drug Stores; Operating Expenses in the Wholesale Drug Business; Operating Expenses in the Wholesale Dry Goods Business in the South; Operating Expenses in Retail Grocery Stores; Operating Expenses in the Wholesale Grocery Business; Operating Expenses in Retail Hardware Stores; Operating Expenses in Retail Jewelry Stores; Operating Expenses in the Wholesale Paint and Varnish Business; Operating Expenses in Retail Shoe Stores; System of Accounts for Shoe Wholesalers; Operating Expenses of Retail Stationers and Office Outfitters.

[2] Cf. *Trade Association Activities,* United States Department of Commerce, 1927.

given trades. It did not, however, make detailed studies of a kind which correspond to the detailed studies made of factory costs, until a time study of salesmen's time was made which was similar to factory time studies. Recently, moreover, the company has started on the task of breaking down the salesmen's expenses and allocating them to the product sold. Forty major items are being studied with reference to the salesman's salary, traveling expenses, sample expense and expense of service to customers. It is also breaking down the major lines by towns, showing gross sales of each of the major lines, the standard deduction for secondary cost and the gross yield. Then from this gross yield the intratown expense is deducted, leaving the net margin by lines by towns. Against this figure the intertown expense must also be allocated. With this information it will be possible to get some idea of what it actually costs to get sales in given territories; and so to form the basis for conclusion whether the return is worth the price.

Just as in factory experience, perhaps the chief contribution of establishing costs is the impetus that such cost finding gives to the establishment of standards. While costs are valuable in themselves, they take on cumulative value because of this fact.

It is to be expected that marketing cost accounting will not ultimately and fundamentally differ from factory accounting. The emphasis, however, may be different. Says Mr. E. S. Freeman:[1]

> Factory cost accounting has been built around and has always been strongest in the use of direct merchandise costs. The application of joint and indirect costs, on the other hand, is almost entirely joint indirect costs. The way to study and control indirect costs is to study them as direct costs of the operations or function for which they are expended, rather than after the cost of such function has been distributed to other accounts. Hence, I believe that distribution cost accounting should lay its greatest emphasis on the study of costs by operations or functions rather than upon study of costs by merchandise items. The way to understand and control joint costs is to recognize them as such, and to attempt to draw a cost and profit stature of the business with and without each marginal factor. Hence, I believe that distribution cost accounting should lay less emphasis on comparing complete costs with the complete sales and more emphasis on comparing marginal costs with marginal sales.

It is important to build up the idea that distribution accounting is as necessary and as capable of accomplishment as factory accounting. There is at least a great deal of costing experience by which to be guided, which is a long step ahead of where the factory accountants had to start when their work was all new.

[1] Freeman, E. S., "Distribution Costs," The International Cost Conference, Atlantic City, June 17, 1926.

Quotas. The total of how much merchandise should be sold can be assumed to have been determined by the merchandiser in his coordination of market demands and factory schedules. There remains, however, the problem of how much merchandise each unit of the selling organization shall be asked to dispose of in the light of the merchandiser's estimate. This means the establishment of a quota of sales for each geographic area, and the establishment of a quota for each salesman in that area.

In making sales quotas there are several methods used. The quota may be as coldly scientific as possible, just as a budget aims to be. But no budget, be it ever so carefully constructed, can be entirely accurate. Furthermore, the definiteness of an objective is to most salesmen not so much of a spur as trying to achieve a less definite but more difficult goal. Hence the general practice in setting sales quotas is that they shall be optimistic. The general belief is that to ask for a quota lower than a figure which any district or other sales group has reached in past years, is to build up a set of mind ready to use this low figure as an excuse. Any spur that the quota exerts, therefore, must be on the plus side and not on the minus side. Against this argument, the point is made that the setting of quotas which call for continual gains in volume each year must finally reach a point where further increases are manifestly impossible. To demand the manifestly impossible is, of course, to upset every purpose for which a quota was established in the first instance.

It is interesting, however, that in the light of experience to date this latter point seldom seems to be reached. If any reasonable quota is set, some sections of the selling organization always reach it and a fair proportion usually exceed it. This evidence would indicate that there is always some slack in a selling organization that an alert management will always be searching for by one method or another, and that in the final analysis little as yet is actually known about the sales potentialities of any given area for any given line or lines of merchandise.

A balance between optimism and pessimism is greatly aided where a merchandise estimate exists for the various lines and even for separate items of merchandise. This estimate can be taken as a base figure in which no attention need be paid to psychological effects, and in which the pessimist may have full sway if there be sufficient cause for pessimism. It is probable that sales increases of the future will come from analysis rather than from high-pressure selling.

The sales quotas may be set in commodities or in dollars. To break the quota down into sections for actual operation the dollar figures are most often used, because a quota in dollars compared with the previous year's achievement exercises a simpler and sharper appeal than does a

quota set in terms of units of goods. The dollar figure alone has one great weakness in that it tends to unbalance sales efforts in favor of the quick selling items where the line is a varied one. A district or an individual salesman will naturally reach the quota set by as direct a means as possible. The quick selling items may or may not be the profitable items and may or may not be desirable in terms of production, but all of these things are blanketed under the dollar figure.

Good practice will dictate that in many places the sales quota will be set in both terms so that the weaknesses of dollar quotas by themselves may be obviated. Where merchandising is actively functioning, there is no need for much trouble on this score, since the merchandiser will get his reports in terms of commodities and will bring quickly to the attention of the sales managers any cases of bad slipping of a commodity in individual districts.

Quotas are sometimes used as the basis of special awards, either systematic additions to pay or cash or trophy prizes of one sort or another. If the sales quotas are the basis of any sort of award, it follows that the most scrupulous care must be taken in their setting. A task poorly defined is a fertile source of trouble.

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CHAPTER XIV

CLERICAL OPERATION STANDARDS[1]

THERE is a current popular belief that standards in office work pertain only to methods of work, quantity of output, and quality of personnel. This assumption ignores the fundamental principle that physical and other external conditions constitute a component part of any problem, and must therefore be given consideration. As a matter of fact, high standards of output, for instance, are possible only when other essential factors, such as physical equipment, are considered; and generally the highest results are obtainable only through the use of the most complete available knowledge concerning every factor involved in the management of an office.

The problems of office management may be classified into sixteen main divisions, as follows: arrangement, equipment, use of office machinery, correspondence, filing, stockkeeping, intercommunication, forms, organization, personnel methods, training, routines and methods, salary standards, clerical output, control of output and turnover of employees.

Each of these may be subdivided, so that a total of some ninety-three subdivisions is derived. Standards for each of these numerous subdivisions may be obtained by means of research of the type described in Chapter VI. This chapter is concerned only with a few illustrative major standards.

1. *Arrangement.* Economical use of space requires consideration of the amount of space occupied and the amount of travel through that space. The size of desk that meets most requirements is sixty by thirty inches. The necessary space occupied by the worker is of the same dimensions, making the net space occupied by the desk and the worker five by five feet, or twenty-five square feet. It is most economical to place desks side by side in pairs, with an aisle three feet wide on each side. Each clerk therefore uses one-half of a three-foot aisle for a distance of five feet or 7.5 square feet, so that the total space occupied by each clerk is 32.5 square feet. If an allowance of 17.5 square feet is added for miscellaneous filing and other equipment, a general standard of fifty square feet per clerk is obtained. This total has been found by experience to be ample except in cases where an unusual amount of miscellaneous equipment is required. For heads of departments or executives, a greater allowance must be made on

[1] By William H. Leffingwell, W. H. Leffingwell, Inc., New York.

account of the character of their work. The standard for them is one hundred square feet.

Arrangement should always be such that work, in the dominating routines at least, travels in straight lines.

Adequate light, both natural and artificial, is manifestly necessary. For best use of daylight the building should not exceed forty feet in width, with windows covering two-thirds of the area of each wall. There should be no obstructions for forty feet outside the windows, either horizontally or vertically. These, of course, are ideal conditions which, in these days of skyscrapers, are rarely possible of realization. Artificial light should be ample in volume and thoroughly diffused. The totally indirect method of lighting is best for attaining such diffusion. The minimum quantity of light, at desk height and evenly distributed, should be ten foot-candles. There is no objection to a greater intensity of light provided there is proper diffusion, but higher intensities are difficult to obtain in most buildings because conventional wiring will not carry the necessary wattage.

Circulation aisles should be sufficient in number and width. An aisle should run on each side of a pair of desks, with cross aisles placed at distances of approximately twenty feet. Main traffic aisles should be six feet in width; others a minimum of three feet.

Noise is a disturbing factor in most office work. Noisy machines should, where possible, be segregated and ceilings acoustically treated to absorb reverberations. Hair felt, celotex and acoustical stone or plaster can be used for this purpose.

All offices should be provided with cloak rooms. In large offices a check room located near the entrance is the most economical.

In the matter of toilet facilities, more than the legal requirements represent a hygienic minimum. In the office time and convenience are both highly important factors, and experience shows that the legal minimum is inconvenient and wasteful of time. For each sex, one seat to fifteen persons should be provided. In women's lavatories an ample provision of mirrors should be made.

Drinking fountains, either of the "bubbler" type, or provided with paper sanitary cups, should be placed in such locations that the worker does not have to walk more than an average of twenty feet in order to reach them.

2. *Equipment.* The usual type of office equipment is too frequently entirely unsatisfactory for the use to which it is put. Desks rarely have suitable writing surfaces; there are too many drawers in them, and these drawers are not subdivided to hold standard sizes of supplies. Chairs are uncomfortable and do not induce a correct sitting

posture. It is often advantageous to design special equipment for particular operations.

Filing cabinets should be of the vertical type, with dividing partitions or other devices for holding the material in an upright position without the use of follow blocks.

3. *Office Machines.* The variety of office machines is too great to allow a detailed description here, but the principles underlying the use of such machines may be outlined. Machines are justified when they: (1) save labor, (2) save time, (3) promote accuracy, (4) avoid monotony. The saving in labor must be actual, however, and proved in each instance by experiment. It should not be taken for granted, either, that all types of persons dislike monotonous work, or that all types of such work are equally distasteful to the same person. For many kinds of monotonous work persons may be found who desire just that kind of monotony. The problem of monotony is most difficult when an operation demands a skill to be found only in persons who dislike the kind of monotony inherent in the operation.

Idle machinery is an expense in the office as it is elsewhere. Effort should always be made to utilize every piece of office machinery profitably, and idle time should be estimated when considering the purchase of such equipment.

4. *Correspondence.* Much of the correspondence in an office is of a repetitive, routine character, and in such cases the principle of re-use should be observed; *i.e.*, standard forms, form letters and form paragraphs should be available for letters identical in nature.

5. *Filing.* Filing work should be 99 per cent accurate, one error in one hundred pieces being the allowable maximum of error. Only such material as is likely to be called for at a future date should be filed. Material of a clearly temporary value should be filed in a suspense file and later destroyed.

There are various systems of filing, such as the chronological, numerical, alphabetical, geographical and subject, the manner of use determining the particular method or system desirable in a particular circumstance. Subject files may be either the Dewey decimal system (ordinarily redesigned for business use) or the mnemonic system. The latter is the more flexible and easily handled.

The custody of the files should remain solely with the filing department; others should not be permitted either to file material or to take it from the files.

6. *Stockkeeping.* The principles of office stockkeeping are identical with those of production stockkeeping presented in Chapter XV.

7. *Intercommunication.* The telephone is the most satisfactory method of communication. Either an outside or inside system may

be used. A system which automatically makes connections eliminates the cost of operators.

A fair measurement of the effectiveness of intercommunication methods may be made by ascertaining the ratio that the average number of clerks standing or moving about at one time bears to the number seated at desks. If the former is in excess of 10 per cent there is something defective in the methods of office intercommunication. A messenger system from desk to desk at periods not exceeding twenty minutes, will greatly improve conditions. Communication with comparatively distant interoffice points may be effected through either the telautograph or the telegraph typewriter. Each of these delivers instantaneously a written message, the former in long hand and the latter in typewriting.

8. *Forms.* Printed forms expedite clerical work, but as a rule they are not adequately standardized. In the designing of forms the following factors should be given consideration:

a. Purpose has always an important bearing on design. There is no advantage in having a printed form if a blank sheet will serve the intended purpose.

b. The manner in which a form is to be used determines not only the design but the kind and quality of paper.

c. Much of the paper now available has a temporary life. Such paper should be used only for forms which do not need to be preserved for more than one to three years. Semi-permanent forms which are required to last from five to fifteen years should have paper of from 20 per cent to 60 per cent rag content. All forms which must last twenty years or more should have paper with a rag content of 75 per cent to 100 per cent.

d. As a rule there is no necessity for more than the following nine standard sizes: 3 x 5 inches; 3½ x 8½ inches; 4½ x 5½ inches; 7 x 8½ inches; 8½ x 14 inches; 3½ x 4½ inches; 4 x 6 inches; 5½ x 8½ inches, and 8½ x 11 inches. The standard sizes for cards made from index bristol to fit all standard equipment are: 3 x 5 inches; 4 x 6 inches, and 5 x 8 inches.

e. A wide range of colors in forms is neither necessary nor advisable. Certain colors, such as blue, pink, green and brown, should be avoided, as matter printed or written on them is difficult and fatiguing to read under artificial light. Canary yellow, corn yellow, golden-rod and other shades of yellow are preferable colors.

9. *Organization.* Clearly defined lines of responsibility and authority throughout the office organization are matters of paramount necessity. Wherever feasible the organization should be functional, as it is otherwise practically impossible to control output where operators

perform many different tasks. An organization chart is desirable. It should be kept up to date, and an organization write-up provided, in which the positions shown on the organization chart are described in detail. For every standardized operation, carefully drawn standard practice instructions are indispensable.

10. *Personnel Methods.* In personnel supervision one of the most essential standards is a progressive record of the performance of each employee, on which should also be recorded the conditions and changes of salary and promotion. In offices where scientific management has been developed, it is customary to keep monthly statements of the average production on such records. Standard tests should be devised for discovering the ability of applicants for employment, but the various psychological tests should be used only under the supervision of skilled psychologists. Specific work tests of a standard piece of work of the character which the employee is to perform, on which standard performance is known, are a great advantage.

11. *Training.* High standards of clerical output require standard training methods to enable the employees to accomplish the results desired. This training is best imparted by the departmental instructor, who for a very considerable period gives close attention to the work of the learner. A careful study should be made of possible lines of promotion from one position to another, and these lines should be pointed out to the employees so that they may prepare themselves for the higher positions available. The Gilbreth three-position promotion plan—in which a worker is a student under a worker next higher in grade and a teacher of one next lower in grade—may be used to advantage in the office.

12. *Routines and Methods.* Routines and methods naturally differ in different types of business, but there are certain common and essential principles that must be considered in scientific management. The first is that all work must flow straight forward; there should be no back travel, and work should never swerve from side to side through a room or building while passing from step to step. The simplest method of accomplishing a desired result should always be used, and uniformity in procedure established wherever possible. If there are in the office several routines of similar character and purpose they should be handled in an identical manner. In the standardization of methods there must of course be separate research to determine each new method, and there are literally hundreds of methods which can be standardized. The vitally important thing is to devise a method which, while being effective, completes an operation with the minimum amount of effort, and is always used when that operation is being performed. This is rarely found to be the case in office organizations

where the work is not standardized; in such places it usually will be found that the workers perform the same operation in a great many different ways.

13. *Salaries.* Salary standardization requires that salaries shall not be below the market rate, that they should not be unnecessarily high, and that there shall be standard salaries for similar positions. A clerk of a certain grade doing a certain kind of work should be paid a sum within a certain definite and prescribed salary range. In large organizations, the question of salary standardization requires the most careful research, and the most thorough consideration of the various classifications and their standards. When this is done, it will be quickly found that such general terms as stenographer, typist, bookkeeper, etc., are inadequate job descriptions to cover the work performed under these conventional names.

14. *Output.* While the quantity of clerical output performed should meet standards determined by research, it should be remembered that in office work particularly one often finds hidden differences in operations which at a casual glance appear to be the same—differences that must by no means be overlooked. Thus the simplest sort of operation, such as typing addresses on envelopes, may vary as to details in several ways. The copy from which the address is taken is a factor, as is also the particular manner in which the address is typed; and both of these have a number of variables. Variables of this sort apply to nearly every kind of operation in the office; therefore it is not possible to establish and cite standards which are universally applicable, except for a very few operations. The standard output for typing letters from phonograph dictation or from shorthand notes, is two hundred square inches per hour, in pica type, a square inch of pica typewriting being one line, six inches long, or six lines, each one inch long. Other typical standards are: typing envelopes, 240 per hour; affixing postage stamps, 4,900 per hour.

15. *Control of Output.* In controlling output the first and most important consideration is to handle work so there shall be an uninterrupted flow. This condition is very difficult of attainment in office work, and requires the utilization of special control methods.[1] Scheduling the work—especially routine, intermittent and special work—is the standard mechanism for the controlling of output. Office work is highly subject to peaks and valleys because most of it originates outside of the office, and its quantity is therefore a matter outside the control of the office manager. At certain seasons, in almost every kind of business, the work is very much heavier than at other times. The problem of the peak should be carefully studied, and the mis-

[1] Cf. Chapter XXI.

cellaneous work so planned that the weight of the peak shall not fall with full force upon the organization. A standard method of handling peaks can be devised in each particular instance. It is also essential to the control of output that there shall be adequate records and reports covering performance in every section of the office.

16. *Turnover of Employees.* A zero labor turnover is, of course, never possible, but the standard turnover in an American office should not exceed 10 per cent.

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CHAPTER XV

FACTORY OPERATION STANDARDS[1]

THE definition of a standard in scientific management as "that which is set up as . . . a criterion, established as a result of scientific investigation representing the present stage in the development of the art,"[2] indicates that a standard is fixed only until a supplanting standard has been discovered that warrants the expense of change.

Factory operation standards are the product of such research as has been described in Chapter VII. A condition or procedure cannot be considered as standard until research, experiment and use have proved conclusively that for the particular purpose it is superior to any other condition or procedure.

After a standard is established, understanding, acceptance, usage and vigilance are required for its maintenance; for on the one hand, if the standardizing motive is withdrawn, the standard will deteriorate through inertia; and on the other hand, parodoxical as it may seem, if the standardizing motive remains, the very forces that worked with diligence to establish the standard will work with equal diligence to discover a better one to supplant it.

A standard is usually dependent on other standards and the maintenance of all is essential to the maintenance of any one. Water freezes at 0° centigrade at sea-level atmospheric pressure. The establishment of one of these conditions is not sufficient to freeze water if the other condition is not also established. A certain method may produce a certain output on a machine; but it is always the case that the standard output from that method is dependent upon certain standard conditions of parts of the machine.

It should be noted that it is practically impossible to maintain high standards in juxtaposition to poor standards. Throughout an industrial establishment there is always a leveling tendency with respect to standards—a Gresham's law. The association of high standards with low standards has much more tendency to pull down the high standards than to raise the low. For this reason, precise standards of

[1] By Leslie E. Bryant, Assistant to Engineer, Armstrong Cork Company, Linoleum Division, Lancaster, Pa., and G. E. Schulz, Consulting Engineer in Management, New York.

[2] Hathaway, H. K., "Standards," *Bulletin of the Taylor Society*, Vol. XII, No. 5, October, 1927, p. 491.

method and accomplishment must be built upon precise standards of product, materials, equipment and tools.

The principal standards of a scientific management shop may be classified as follows: equipment, tools, materials, product, method and accomplishment.[1]

Equipment. By the equipment of a plant is meant all machines, machine attachments, transportation equipment and auxiliary equipment involved either directly or indirectly in the manufacture of a product. Tools and small equipment are classified separately. Inasmuch as equipment as here classified involves the greater portion of the investment in a plant (aside from land and buildings) its standardization is most important.

1. *Machinery.* By machinery is meant that equipment of a plant which is involved directly in the processing of the product or which is necessary as a supporting or power-transmitting accessory of the same. In some machinery, standardization is inherent in the design of the machine. Other machinery requires the application of standardized conditions to the designed machine when in use. In standardizing machinery the following conditions are brought to the highest state of perfection which the economic value of the process will permit.

a. The space which a machine occupies is valuable. A building must be built around it, which in turn must be heated, lighted and maintained, all of which is costly. It is frequently the case that a few highly productive machines will occupy much less space than many machines of lower production value. The space is then released for other purposes. The space occupied by a machine includes all the space needed properly to operate the machine.

The space occupied by a machine depends upon the design of the machine. It is hardly possible to constrict the space occupied by a machine after construction. In certain machines this can be accomplished by a redesign of the machine.

Provision is made at each machine for an adequate amount of space for the proper quantity of material in process ahead of the machine. In the continuous or repetitive industry this space may take the form of a conveyor leading to or past the machine. In a non-repetitive industry space is usually occupied by trucks, platforms or piles of material.

Space is provided at all machines for operators to occupy, and move from point to point about the machine as its operation requires. Good design provides for a minimum of moving about by operators, but adequate space for such movement.

With respect to all machines which have material entering and

[1] Hathaway, H. K., *op. cit.*

leaving the machine, it is necessary to provide ample space for the handling of all material and tools to and from the machine. In Figure 26 is shown an application of space standardization in a machine shop. There are definite divisions made in the space of the factory for machines, working space around the machines, space for material awaiting process and space for the movement of men and material to different parts of the building.

b. When material is processed in a machine it is necessary to hold or support this material during the processing. The holding may be entirely independent of the processing units, or holding may be a part

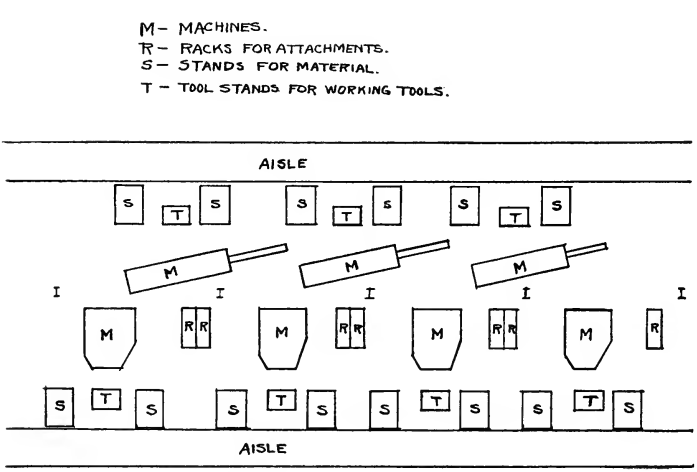


FIG. 26. ARRANGEMENT OF MACHINES AND OTHER FACILITIES

of the processing. A standardized machine is provided with adequate material-holding devices.

c. Tools operating in a machine require a means of holding them to the machine in a manner that permits their proper functioning. The design or purchase of a machine should be based on the proper application of the tools to the work.

There are many types of tools on the market for which current usage has standardized the manner and sizes of holding devices to be used. It is economical to use these standards where possible.

The time required to manipulate a tool-holding device is the final factor in determining the nature of the tool-holding device.

d. The proper speeding of a machine does not mean that the ma-

chine must be speeded up to run faster, but that the relative speeds of the various parts are so coordinated that the proper relationship between the parts is secured. The speed of the machine is determined by the laws of processing involved. Frequently the capacity of the material-handling equipment is allowed to be the determining factor in the speed of a machine. This is an indication of poor standardization at that point.

The range of speeds of a machine's parts should be great enough to cover the range of variables involved in the science of processing the material. Provision should be made for ready increase of these speeds in case developments in the science of processing call for such increase. The speed of the machine must be consistent with the life of the tool under all the conditions of its use.

e. The relationship of maintenance to a machine is a highly important one.[1] A properly designed machine takes into consideration in the design, the ready adjustment and replacement of parts; the proper lubrication of the moving parts of a machine increases the life and permanence of adjustments. These factors reduce the time that a machine undergoes idleness due to maintenance.

The time required for the performance of a maintenance operation is important in the effect it has on the idleness of the machine. Simplified maintenance results in more complete maintenance with its minimum of down time.

Standardization of design results in savings in maintenance due to the increasing familiarity of the personnel with the machines, and to the reduced cost of spare parts insurance.

2. *Machine Attachments.* Machine attachments comprise those parts of a machine that in themselves could not do any processing, but are used under certain producing conditions. Repetitive or continuous industries are very little concerned with machine attachments, for in those industries the attachments are made a part of the machine. It is only in the intermittent and non-repetitive industries that the machine attachment becomes a problem. Here the problem of adjusting the machine to different operations forces the machine attachment into a class by itself. In some respects its treatment resembles a machine and in others it is handled like a tool.

a. The use of an attachment on a machine involves provision on the machine for readily taking the attachment.

Standardization requires that the means of fastening an attachment be simple and self-aligning.

b. Tool holding in an attachment presents the same problem as tool

[1] Cf. Chapter XXIII.

holding in a machine proper. The problems discussed in that connection are equally problems of attachments.

c. The speeds and feeds of attachments are determined by the same factors as are speeds and feeds of machines.

d. The problems involving the maintenance of attachments are: provision for periodic inspection for wear and defective parts, with replacement for required parts; maintenance of proper lubrication service to the attachments, and protection of the attachments from the elements and abuse while not in use.

e. The problem of proper storage of machine attachments when not in use is one of the necessary elements of plant standardization. The attachment must be found in the place assigned to it and in proper condition.

All parts of an attachment are accounted for and placed in the same place as the main attachment. These parts are marked in such a manner that there is no question about their proper place on the attachment.

3. *Transportation Equipment.* By transportation equipment is meant the equipment involved in changing the locations of materials. The main things to standardize in transportation equipment are its adaptability to the product, its ability to function at a speed equal to machine production, its ability to function continuously with little or no holdup to machine production, and its delivery of material to the point desired.

In the layout of a factory it is self-evident that as little transportation as possible should be done. However, as it is a necessity at certain points, it should be treated as a definite problem of machine standardization.

a. The material moved determines the nature of the transportation equipment. Continuous or repetitive industries can use the conveyor to a very large extent. Intermittent or non-repetitive industries must make use of a more flexible means of transportation such as lift trucks, cranes, electric and gasoline trucks.

b. The speed with which a piece of transportation equipment moves is governed by the volume of material produced by a process in a given time. The material should be moved to and from a process at such speed that neither congestion nor scarcity of material can occur under normal operating conditions. In the case of a conveyor moving constantly between two points this can be taken care of readily by adjustments in speed.

4. *Auxiliary Equipment.* The auxiliary equipment of a plant consists of those units which have no direct contact with the production of a plant, but which are necessary for human comfort, sanitation, etc. Here the points to be standardized may be grouped as follows:

a. Heating and ventilation requirements of industries differ in the degree to which they must be provided. The minimum requirements provided in most state or federal statutes usually fall short of providing a satisfactory standard condition. The conditions that properly satisfy each manufacturing problem must be worked out at the particular locality. The only standard principle that can be presented is that the men working at a process should not be handicapped by lack of or an oversupply of either heat or ventilation.

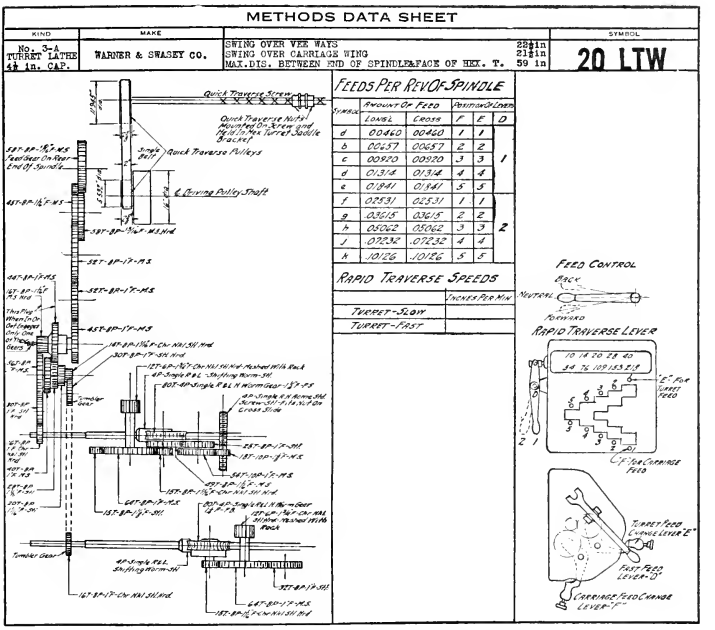


FIG. 27A. DATA SHEET FOR TURRET LATHE

b. The sanitary equipment of a plant should be so standardized that a man working in any capacity will feel as safe from disease in the plant as he feels in his own home. He should be able to leave the factory as clean as he can leave his own home.

c. The control of light in manufacturing processes is important. Too much light causes glare and eyestrain; too little light causes eyestrain. In either case there is loss due to uncertainty of vision. Wherever there is eyestrain on a job there is a greater labor turnover

and resultant losses. Illumination engineers have worked out the proper lighting standards for various kinds of work, and detailed information may be obtained from many sources.

5. *Availability of Equipment Data.* In a plant operating under scientific management one of the noticeable features is the readiness with which facts are ascertainable. This condition is dependent upon having data regarding all standards at the disposal of those who must

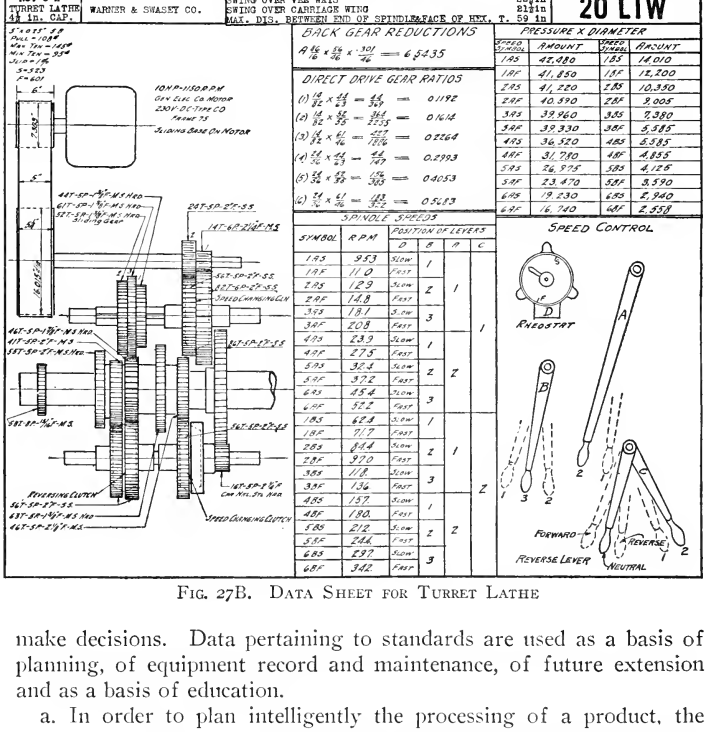


FIG. 27B. DATA SHEET FOR TURRET LATHE

make decisions. Data pertaining to standards are used as a basis of planning, of equipment record and maintenance, of future extension and as a basis of education.

a. In order to plan intelligently the processing of a product, the decisions on how a product is to be processed must be based upon the capacities of the various machine units in the plant and the variables that affect this capacity.[1]

The preparation of a task prior to the performance of an opera-

[1] Cf. Chapter XXII.

tion requires the knowledge of facts regarding the equipment, tools, materials and men that are available for the operation. With all of these data available the task can be made up from proper combinations of work elements.

The available speeds and feeds of all equipment are known and recorded in a form that is readily available for use. Figures 27A and B are speed and feed diagrams showing the form in which data are set up.

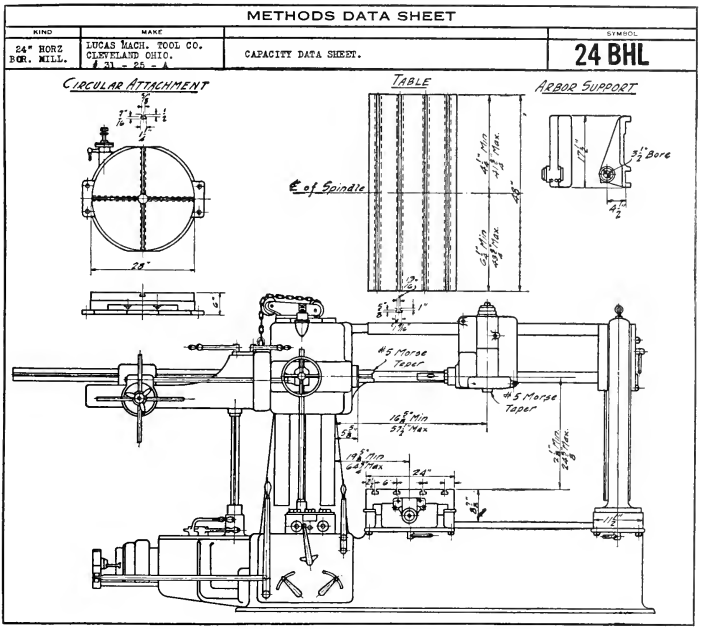


FIG. 28. CAPACITY DATA SHEET FOR BORING MILL

The capacity of all machines and work places is recorded in a definite plan of each work place or unit. Figure 28 shows the capacity data that are used in the routing of work and in the preparation of tasks for a horizontal boring mill in a plant making a diversified product.

Charts, special slide rules and formulæ form part of the mechanical devices necessary for the more rapid determination of solutions of machine problems.

b. Manufacturers' operating instructions are important sources of information on the proper procedure regarding the care and adjustment of machines.

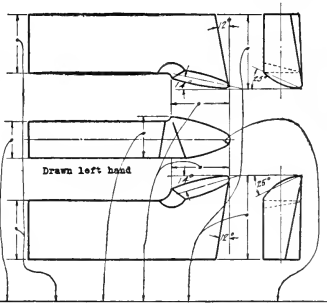
Repair parts lists are a valuable assistance in ordering replacements. As much time can be lost because of improper description of the broken part as is lost in obtaining the part and replacing it.

A record of all maintenance performed in a plant keeps the data regarding these machines up to date and forms a basis for determining action in regard to future maintenance or purchase of machines of a particular type.

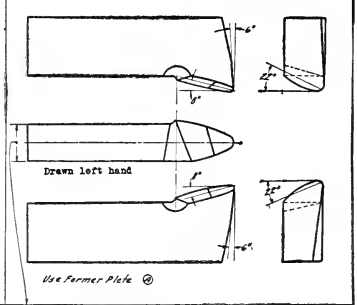
METHODS DATA SHEET

KIND	MAKE		SYMBOL
PARING TOOLS	ARMSTRONG CORK CO.	RIGHT & LEFT HAND STRAIGHT SHARP ROUND NOSE ROUGHING TOOLS, USED FOR STEEL ON ENGINE LATHES.	PRSB-C

FORGING



GRINDING



Use Former Plate ②

TOOL DATA

Size Tl	Dpt Steel	Width Nose	Lgth Nose	Hgt Nose	Stock Lgth	Rad.
5/8	1	11/16	13/16	1 1/4		1/8
3/4	1 1/8	13/16	1	1 3/8	10	3/16
7/8	1 3/8	31/32	1 1/8	1 3/4	12	1/4
1	1 1/2	1 1/8	1 1/4	1 7/8	15	5/16

GRINDING DATA

Size Tl	Left Hand Tools				Right Hand Tools				Symbol N.H.	Symbol L.H.
	Top Face		Nose		Top Face		Nose			
	Horiz Angle	Vert Angle	Horiz Angle	Index Number	Horiz Angle	Vert Angle	Horiz Angle	Index Number		
5/8	97.4°	112°	96°	2	97.4°	68°	96°	2	PR 5/8 SB	PR 5/8 SC
3/4	97.4°	112°	96°	4	97.4°	68°	96°	4	PR 3/4 SB	PR 3/4 SC
7/8	97.4°	112°	96°	6	97.4°	68°	96°	6	PR 7/8 SB	PR 7/8 SC
1	97.4°	112°	96°	8	97.4°	68°	96°	8	PR 1 SB	PR 1 SC

FIG. 29. DATA SHEET FOR PARING TOOLS

c. The use of equipment data as a basis of education is brought about by the fact that a large majority of modern machinery is enclosed or guarded, so that a clear view of its working principles is not readily obtained. In order to give men a clear idea of the operating conditions of a machine it is necessary to have sectional views, gearing diagrams and other assisting data.

Equipment data are valuable as records of past design. With exact records of performance it is easier to eliminate the errors of design that have occurred in older models.

Tools. In considering tools as objects of standardization it is well to define tools themselves. By tools are meant those small parts that are used in the holding or processing of material, that are subject to replacement due to dulling or wear, or that are used for holding parts to the machine.

Tools and small loose equipment present one of the most fertile fields for factory standardization. With proper standardization of tools and the mechanism for handling them, the savings in material, time and effort of the operating personnel and in investment are enormous. The following steps are to be covered in standardizing the tool equipment of a plant.

1. *Design.* Upon the correct design of a tool depends its correct functioning to produce the most economical results. In designing a tool it is necessary to consult the science of processing the material involved and make the tool correspond to the condition laid down by the development of the science. Figure 29 shows a lathe-turning tool designed on the basis of the experiments made by Frederick W. Taylor and described by him in "On the Art of Cutting Metals."

Because of the confusion which existed when the majority of machine and tool manufacturers were using their own standards, a number of definite standards have been created by united action on the part of manufacturers of machines, manufacturers of tools and engineering societies. With the adoption of these standards, it is now possible to purchase tools that are interchangeable over a range of machines made by different manufacturers. Figure 30A shows a table of standard nut sizes and figure 30B a corresponding table of standard wrench sizes.

With the adoption of definite tool standards it is possible for a tool manufacturer to manufacture for stock consistent with demand, and this results in producing the tool at a lower cost.

2. *Storage.* Tools are required for use at a given place at a given time. To accomplish this the tool must have definite location to which point an order for issue is always referred. Tool storage standards are required to accomplish this condition.

a. The first step in attempting to arrange a tool storage is to classify the tools according to some obvious method of classification. This classification may be developed according to use, size or frequency of issue where the latter is known. All have their advantages, but the trend in scientific management is to classify mnemonically according to use.[1] In such a classification the main divisions of the classification are first developed, and then the varieties and variations of

[1] Cf. Chapter IX.

FINISHED SQUARE AND HEXAGONAL BOLT HEADS

Diameter of Bolt (D)	Width Across Flats		Minimum Width Across Corners		Height		
	Maximum	Minimum	Hex.	Square	Nominal	Maximum	Minimum
1/4 0.2500	7/16 0.4375	0.428	0.488	0.588	3/16	0.194	0.180
5/16 0.3125	9/16 0.5625	0.552	0.629	0.758	15/64	0.242	0.227
3/8 0.3750	5/8 0.6250	0.613	0.699	0.842	9/32	0.289	0.273
7/16 0.4375	3/4 0.7500	0.737	0.840	1.012	21/64	0.337	0.319
1/2 0.5000	13/16 0.8125	0.799	0.911	1.097	3/8	0.385	0.365
9/16 0.5625	7/8 0.8750	0.861	0.982	1.182	27/64	0.433	0.411
5/8 0.6250	15/16 0.9375	0.922	1.051	1.266	15/32	0.481	0.457
3/4 0.7500	1 1/8 1.1250	1.108	1.263	1.521	9/16	0.576	0.549
7/8 0.8750	1 5/16 1.3125	1.293	1.474	1.775	21/32	0.672	0.641
1 1.0000	1 1/2 1.5000	1.479	1.686	2.031	3/4	0.768	0.733
1 1/8 1.1250	1 11/16 1.6875	1.665	1.898	2.286	27/32	0.863	0.824
1 1/4 1.2500	1 7/8 1.8750	1.850	2.109	2.540	15/16	0.959	0.916
1 1/2 1.5000	2 1/4 2.2500	2.222	2.533	3.051	1 1/8	1.150	1.100
1 3/4 1.7500	2 5/8 2.6250	2.593	2.956	3.560	1 5/16	1.341	1.284
2 2.0000	3 3.0000	2.964	3.379	4.070	1 1/2	1.533	1.468
2 1/4 2.2500	3 3/8 3.3750	3.335	3.802	4.579	1 11/16	1.724	1.651
2 1/2 2.5000	3 3/4 3.7500	3.707	4.226	5.090	1 7/8	1.915	1.835
2 3/4 2.7500	4 1/8 4.1250	4.078	4.649	5.599	2 1/16	2.106	2.019
3 3.0000	4 1/2 4.5000	4.449	5.072	6.108	2 1/4	2.298	2.203

All dimensions given in inches.
D = diameter of bolt.

FORMULAE

Width across flats of finished hexagonal bolt heads shall be 1½ D except as follows:

Diameter of Bolt	Width Across Flats
1/4—9/16	1 1/2 D + 1/16

with adjustments in 16th inch sizes to eliminate 32nd inch size wrench openings.

Tolerance for width across flats shall be minus (.015 D + .006).

Height of heads from top of head to under side of washer face shall be ¾ D.

Tolerance for height of heads shall be .030 D + .005 from the minimum.

Minimum width across rounded corners of hexagon equals 1.14 times mimimum width across flats.

Minimum width across rounded corners of square equals 1.373 times minimum width across flats.

The finished top shall be flat and chamfered; angle of chamfer with top surface shall be 30 deg.; diameter of top flat circle shall be 100 per cent of the nominal width across flats.

Tolerance on diameter of top flat circle shall be minus 15 per cent.

Finished bolt heads shall be at right angles to the body within 2 deg. and concentric with the body within a tolerance of 3 per cent of the distance across the flats.

All finished bolts shall be washer faced, the height of the bolt-head shall be the distance from top of head to the bearing surface. The thickness of washer face shall be 1/64 inch. The earing surface of washer face shall be 100 per cent of the nominal width across flats with a plus or minus tolerance of 5 per cent.

FIG. 30A. TABLE OF STANDARD SIZES OF BOLT HEADS

OPEN END WRENCH OPENINGS

Basic Width Across Flats Bolt Heads and Nuts		Clearance	Tolerance	Dimensions of Measuring Blocks for Wrench Openings	
				Maximum	Minimum
5/32	0.1562	.0014	.005	0.163	0.158
3/16	0.1875	.0016	.005	0.194	0.189
1/4	0.2500	.0018	.005	0.257	0.252
5/16	0.3125	.0019	.007	0.321	0.314
11/32	0.3437	.0022	.007	0.353	0.346
3/8	0.3750	.0024	.007	0.384	0.377
7/16	0.4375	.0025	.007	0.447	0.440
1/2	0.5000	.0030	.007	0.510	0.503
9/16	0.5625	.0035	.007	0.573	0.566
5/8	0.6250	.0040	.007	0.636	0.629
3/4	0.7500	.0050	.008	0.763	0.755
13/16	0.8125	.0050	.008	0.826	0.818
7/8	0.8750	.0050	.008	0.888	0.880
15/16	0.9375	.0055	.009	0.952	0.943
1	1.0000	.0060	.009	1.015	1.006
1 1/8	1.1250	.0070	.010	1.142	1.132
1 1/4	1.2500	.0070	.010	1.267	1.257
1 5/16	1.3125	.0075	.011	1.331	1.320
1 1/2	1.5000	.0090	.012	1.521	1.509
1 11/16	1.6875	.0095	.013	1.710	1.697
1 7/8	1.8750	.0100	.013	1.898	1.885
2 1/4	2.2500	.0120	.015	2.277	2.262
2 5/8	2.6250	.0140	.017	2.656	2.639
3	3.0000	.0160	.019	3.035	3.016
3 3/8	3.3750	.0180	.021	3.414	3.393
3 3/4	3.7500	.0200	.023	3.793	3.770
4 1/8	4.1250	.0220	.024	4.171	4.147
4 1/2	4.5000	.0230	.026	4.549	4.523

All dimensions given in inches.

The sizes given in the table for the maximum and minimum columns are sizes of Go and Not Go gauge blocks used for inspecting wrenches and are not product sizes.

Wrenches shall be marked with the basic width (maximum width of nut) across flats as shown in column 1.

FIG. 30B. TABLE OF STANDARD WRENCHES TO FIT STANDARD SIZE BOLT HEADS

each major group. The classification is made available for the use of all departments.

b. Tools are more readily located when arranged in a tool storage according to a prearranged classification. In arranging for storage according to classification the design of the racks for storage must meet the requirements of the tools to be stored; and each tool location should be marked with the classification symbol of the tool it is to hold.

c. The tool itself should be plainly marked with its classification symbol as a ready means of identification, and as a means of insuring the return of the tool to proper storage rack location. This mark should be in a location on the tool that is clearly visible and not subject to wear or abrasion. The mark should be permanent in nature, being either stamped, etched or cast in.

d. A record should be kept of all tools in a tool storage for the purpose of accounting and replacement. This record will account for the location of all tools, their replacement value, and provide for the current replacement of all tools broken or damaged beyond repair, at the time the damage is done.

3. *Issue and Recall.* In order to have tools at the point wanted at the time they are wanted, certain standards of issue and recall must be maintained.

a. The issue of tools to a man or machine to perform a certain job or type of work varies with the nature of the work. Certain tools that have continuous use and are not subject to much wear are issued permanently with periodic inspection or replacement. Tools that are continuously used, that are subject to dulling, are given an initial issue with current replacement. Where the machine intermittently uses a wide variety of tools the proper groups of tools are delivered to the machine previous to the time of use. Tools peculiar to one machine are issued to the machine, particularly where the tools have no outside value, and are subject to periodic inspection.

b. Tools are recalled to the point of issue in anticipation of use at another point rather than upon demand for issue at another point.

Tools issued for an indefinite period of time are recalled periodically to be checked against standard condition, but tools issued to do a definite job are recalled at the completion of that job. Men leaving employment are required to return all tools checked out to them.

c. Tools represent money invested, and are accounted for in the same manner that money is accounted for.

4. *Maintenance of Tools.* In use many kinds of tools become dulled or deformed beyond the point of efficient use. The restoration of these

tools to their original condition requires the adoption of maintenance standards.

a. All tools are inspected on their return to tool storage and sorted into groups according to the nature of repair they require. Only tools in first class condition are returned directly to the tool storage racks. Worn tools are first reconditioned. Definite standards are provided for each tool with maximum and minimum tolerances; and to maintain high standards of accuracy, tools must be recalled frequently for inspection of condition.

b. A definite record of each standard tool is kept. This is a definite part of tool maintenance.

c. The proper equipment is provided to reproduce or restore the standard tool to its original condition. Machines and tools and gauges necessary to maintain and reproduce all standard tools, not more economically supplied from outside sources, are a part of the equipment provided. Similarly, a record is provided of the setting necessary to place any machine in position to reproduce a standard tool. Figure 29 shows the settings on a Sellers tool grinder necessary to grind the tools shown in the figure.

5. *Manipulation Time.* The manipulation time of tools is one of the governing factors determining the tool to use for a given job. Standardization of tools requires the selection of a tool with low manipulation time.

a. To obtain low manipulation time a tool must be simple to operate, easy to adjust, positive in definite adjustments, readily assembled or taken apart and possessed of inherent accuracy. It is obvious that all tools do not possess all of these features, but where they are possessed they are observed. Figure 31 shows the time involved in manipulating bolts, clamps and blocks—a simple operation, but impossible within the time allowed unless the tools are standardized for the operation, are kept clean and constantly at the high standard that they possessed when originally installed in use.

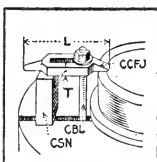
b. To manipulate a tool readily requires that the tool fit properly in position on the machine. The locking and clamping devices must be simple to operate and the operator should have the proper wrenches for operating them. The tool is then readily adjusted to the point of operation.

c. To have standard manipulation times for tools requires that the tool be at the place designated for it when the operator is ready to use it.

6. *Tool Data.* Tool data must be available for the use of all who are involved in tool operations. Tool data fulfill the same part in the

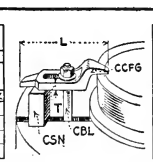
creation of method standards that machine data do. They are used in planning performance and task, in the maintenance of tool standards and in the education of personnel and outside suppliers.

Figure 32 illustrates the tool data that are used in operating a plant under scientific management. It will be noted that the sizes available are shown, the capacities of the various boring bars and the manipulation times for all conditions under which the boring bar will be used.



CCFJ
SIZE OF CLAMP

D	L	T	LBS	OZ
5/8"	9 3/8	1 1/4"	4	8
3/4"	10 1/4	1 5/8"	6	5
7/8"	10 3/4	1 5/8"	8	12
1"	11 1/2	1 5/8"	11	16



CCFG
SIZE OF CLAMP

DIAM OF BOLT	LENGTH OF CLAMP	THICKNESS OF CLAMP	WEIGHT OF CLAMP	
D	L	T	LBS	OZ
5/8"	9 3/8"	1 3/4"	5	10
3/4"	10 3/4"	1 3/4"	6	6
7/8"	10 3/4"	1 5/8"	11	7
1"	11 1/2"	1 5/8"	15	

CCFG
CCFJ
SIZES GIVEN IN THE TABLE
USED WITH **CBL** AND **CSN**

DIAMETER OF BOLT	5/8 AND 3/4				7/8 AND 1					
LENGTH OF BOLT	6	12	14	18	6	12	18	24	30	36
TIME FOR CLAMPING IN MINUTES	0.68	0.71	0.72	0.79	0.76	0.80	0.90	1.00	1.12	1.25
LIFT CLAM, BOLT AND BLOCK TO TABLE (CLAMP AND BOLT REMAINING ON HAND)	0.07	0.07	0.08	0.09	0.08	0.10	0.11	0.13	0.14	0.17
PUT BOLT IN SLOT	0.04	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.06	0.07
UNSCREW NUT FROM BOLT WITH FINGERS	0.13	0.13	0.13	0.14	0.14	0.14	0.16	0.17	0.19	0.22
PUT CLAMP OVER BOLT AND ON WORK	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.07	0.08
PUT BLOCK UNDER CLAMP	0.04	0.05	0.05	0.05	0.04	0.05	0.05	0.07	0.08	0.10
PUT WASHER ON BOLT	0.06	0.07	0.07	0.07	0.06	0.06	0.07	0.07	0.08	0.08
SCREW NUT ON BOLT WITH FINGERS	0.13	0.13	0.13	0.14	0.14	0.14	0.16	0.17	0.19	0.22
TIGHTEN NUT LIGHTLY WITH WRENCH	0.08	0.07	0.08	0.10	0.11	0.12	0.13	0.15	0.17	0.19
DRAW NUT DOWN TIGHT WITH WRENCH	0.08	0.10	0.09	0.10	0.09	0.10	0.11	0.13	0.14	0.12
TIME FOR REMOVING IN MINUTES	0.19	0.20	0.20	0.23	0.27	0.28	0.32	0.35	0.40	0.47
LOOSEN NUT WITH WRENCH	0.11	0.12	0.12	0.13	0.17	0.17	0.19	0.20	0.22	0.25
REMOVE BOLT FROM SLOT, AND ALL TO FLOOR	0.08	0.08	0.08	0.10	0.10	0.11	0.13	0.15	0.18	0.22
TIME FOR CLAMPING IN MINUTES	0.36	0.40	0.40	0.45	0.40	0.46	0.51	0.62	0.70	0.85
LIFT CLAMP, BOLT AND BLOCK TO TABLE (CLAMP AND BOLT REMAINING ON HAND)	0.06	0.07	0.07	0.07	0.06	0.07	0.08	0.10	0.11	0.14
PUT BOLT IN SLOT AND CLAMP ON WORK	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.07	0.09	0.11
PUT BLOCK UNDER CLAMP	0.04	0.05	0.05	0.05	0.04	0.05	0.05	0.07	0.08	0.10
SCREW NUT DOWN WITH FINGERS	0.06	0.06	0.06	0.07	0.06	0.07	0.08	0.10	0.11	0.14
TIGHTEN NUT LIGHTLY WITH WRENCH	0.07	0.08	0.08	0.10	0.11	0.12	0.13	0.15	0.17	0.19
DRAW NUT DOWN TIGHT WITH WRENCH	0.08	0.09	0.09	0.10	0.09	0.10	0.11	0.13	0.14	0.17
TIME FOR REMOVING IN MINUTES	0.45	0.45	0.46	0.52	0.51	0.51	0.58	0.62	0.68	0.78
LOOSEN NUT WITH WRENCH	0.10	0.10	0.11	0.13	0.17	0.17	0.19	0.20	0.22	0.25
UNSCREW NUT FROM BOLT WITH FINGERS	0.12	0.12	0.12	0.13	0.11	0.11	0.13	0.14	0.16	0.19
TAKE OFF WASHER AND CLAMP	0.04	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.06	0.07
REMOVE BOLT FROM SLOT	0.03	0.03	0.03	0.04	0.03	0.03	0.04	0.04	0.05	0.05
PUT WASHER AND NUT ON BOLT	0.11	0.11	0.11	0.12	0.11	0.11	0.12	0.13	0.14	0.15
PUT CLAMP, BOLT AND BLOCK IN TOTE BOX	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.07

TAYLOR ELEMENTARY SYSTEM UNIT TIME

CLAMPING
BOLT AND CLAMP NOT ASSEMBLED
THE TIME GIVEN IN THIS SECTION TO BE USED FOR CLAMPING THE FIRST PIECE ONLY IN LOT

REMOVING
BOLT AND CLAMP NOT SEPARATED
THE TIME GIVEN IN THIS SECTION TO BE USED FOR REMOVING CLAMP FOR ALL PIECES EXCEPTING THE LAST PIECE

CLAMPING
BOLT AND CLAMP ASSEMBLED
THE TIME GIVEN IN THIS SECTION TO BE USED FOR CLAMPING ALL PIECES IN LOT AFTER THE FIRST PIECE

REMOVING
BOLT AND CLAMP SEPARATED
THE TIME GIVEN IN THIS SECTION TO BE USED FOR REMOVING CLAMP FROM THE LAST PIECE ONLY IN LOT

FIG. 31. ELEMENTARY TIME STUDY DATA SHEETS

Material. The standards that factory operation places on material are those of quality, quantity and storage. The maintenance of high material standards leads to the consistent performance of production tasks.

1. *Quality.* The problem of having the most suitable material for each element of a product is one of engineering design and factory standards.

a. To provide proper quality of material consistently, the following details must be covered by definite standards:

The problem of service of the part must have been studied so that

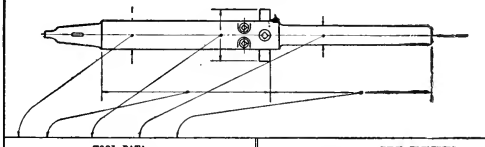
a standard reliable materials specification can be made, to be used when any material is purchased or made for the particular purpose.

Receipt of the material must include its inspection for characteristics and ingredients covered by the standard materials specification. A supplier of material is very careful to supply the material wanted when he knows that it is being checked by the purchaser.

METHODS DATA SHEET

KIND	MAKE		SYMBOL
BORING BAR	DAVIS BORING TOOL CO.	STYLE "N" TAPER SHANK BORING BAR WITH PILOT FOR ENGINE LATHES & HORIZONTAL BORING MILLS.	DBDN

Use Cutters
DCDC, DCDR, DCDS, DCDF



TOOL DATA. TIME ELEMENTS.

Dia	Eff Lgth	Range Bored	Dia Pilot	Lgth	Morse Taper	Wt	Used on	Bars: PL BOR B.	Bars: CHG BOR B.	Bars: REMV BOR B.	Pilot Bush: PL PILOT BUSH	Pilot Bush: REMV PILOT BUSH	Cutters: PL & SET CTRS	Cutters: RESET CTRS	Cutters: CHG & SET CTRS	Cutters: REMV CTRS	Symbol
1¼	12	1 11/16 – 2 7/8	1¼	16	4		BRL	.38	.52	.21	.19	.20	1.49	.86	1.61	.51	DB 1¼ – 12 DN
							LE	.17	.28	.18	.25	.25					
							LT	.19	.36	.26	.73	.87					
1¾	12	2 1/4 – 3 15/16	1⅜	16	4		BRL	.42	.61	.26	.20	.20	"	"	"	"	DB 1¾ – 12 DN
							LE	.18	.31	.20	.25	.25					
							LT	.24	.49	.32	.73	.87					
2¼	16	2 3/4 – 4 7/8	1⅜	20	5		BRL	.46	.70	.31	.20	.20	"	"	"	"	DB 2¼ – 16 DN
							LE	.19	.35	.23	.25	.25					
							LT	.30	.62	.39	.73	.87					
3	16	3 3/4 – 6 1/4	2	20	5		BRL	.54	.87	.40	.20	.20	"	"	"	"	DB 3 – 16 DN
							LE	.21	.41	.27	.23	.31					
							LT	.41	.88	.54	.73	.89					
3½	16	4 1/4 – 7 1/8	2	20	5		BRL	.82	1.43	.58	.20	.20	"	"	"	"	DB 3½ – 16 DN
							LE	.22	.45	.30	.27	.31					
							LT	.46	1.00	.61	.73	.89					
4½	16	5 1/2 – 8 7/8	2	20	5		BRL				.20	.20	"	"	"	"	DB 4½ – 16 DN
							LE				.27	.31					
							LT				.73	.89					
							BRL						"	"	"	"	
							LE										
							LT										

SET RGH FN CUT__"DIA.

Kind of Cut	Dia of bore. To 3"	To 6"	To 9"
Rough	.35	.45	.50
Finish	2.06	2.30	2.55

FIG. 32. DATA SHEET FOR BORING BAR

Upon receipt, the material is definitely marked with an identification tag or code. The use of the wrong material through lack of identification, is a common cause of failure to meet performance standards. Figure 33 (A and B) is a set of materials specifications that show the composition of the material, the physical properties expected of it and the kind of service that it will best perform.

b. The treatment that a material receives in process determines the grade of the resulting product. The proper material for a part may be provided, but if it is not treated properly in process the product will not be consistent with design conditions.

FERROUS METAL SPECIFICATIONS

Chemical Composition

Carbon	Manganese	Phosphorus	Sulphur
.15 to .25	.30 to .50	Maximum .05	Maximum .055

Critical Points

Ac 1	Ac 2	Ac 3
1340° Far.	1395° Far.	1520° Far.

Physical Properties

	Annealed	Cold Rolled or Cold Drawn	Heat Treated
Yield Point in lbs. per sq. in.	30000 to 40000	40000 to 75000	40000 to 75000
Reduction of Area.....	60% to 45%	35% to 30%	60% to 30%
Elongation in 2".....	35% to 25%		35% to 15%

Note: This steel forges well but does not machine well in the natural or annealed state. The machineability can be improved by cold working or by quenching from above the Ac 3 point.

Uses: This steel is recommended for carburized parts such as piston pins, camshafts, rocker arms, valve lifters, shifter rods, rollers, etc. It can be used for unimportant forgings requiring little strength and a small amount of machining.

Typical Heat Treatment:

Carburize 1650° to 1700° F.
Cool in pots or quench in oil or water.
Reheat to 1550° to 1575° F.
Quench in oil.
Reheat to 1400° to 1425° F.
Quench in water.

Where a hard surface only is desired and the ductility of the core is unimportant, the reheat to 1575° can be omitted.

Fig. 33A. Materials Specifications

While hardly a standard in the physical sense, the training of the personnel to realize the importance of proper treatment of material goes hand in hand with the standards.

The classification of material for service is the result of experiences with the material under similar conditions and is a reflection of good engineering practice, and the definite specification of a material for a clearly defined service is required to apply engineering practice to the production of saleable units. Inspection and tests of the finished product verify the use of the proper materials and treatments.

2. *Waste of Materials.* The ideal processing takes place without loss of material. Some processes are such that there cannot be processing without some material being lost as scrap or excess stock. One of the problems of management is to keep this wasted material down to a minimum. This can be accomplished by consideration of the following details:

The amount of stock allowed on a piece should be reduced to the smallest amount consistent with accuracy and economy. The shape of parts is a determining factor in limiting the amount of excess stock allowed. Standard commercial sizes of raw product are purchaseable at lower prices than special sizes. The most economical standard size of material determines the amount of stock that will be in excess. Sometimes by a slight change of design a part can be produced with every little excess of stock.

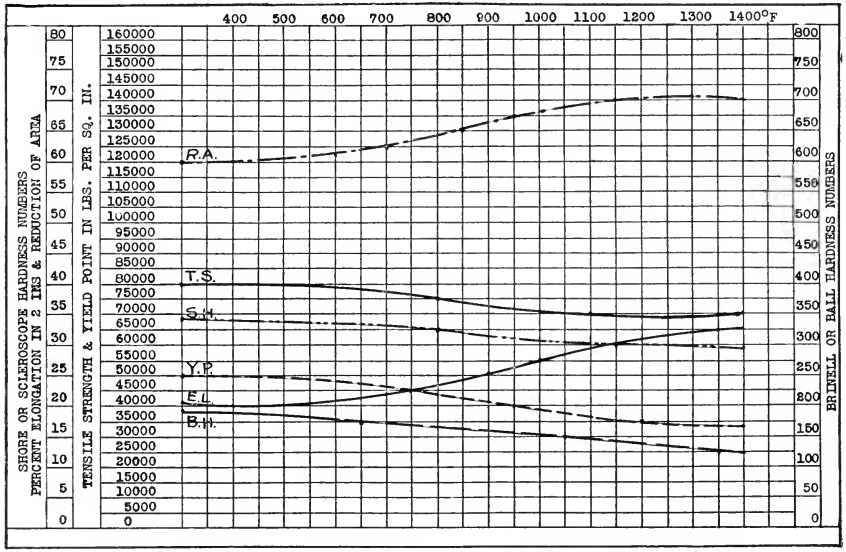
Each trade or industry supplying material which is the raw material of another industry, has certain established sizes that are produced in larger quantities and are therefore more readily, and frequently more economically, obtainable. Raw material in large unit volume occasions traffic and transportation difficulties with the increasing size of the unit; raw material received from a foreign country may be more economically purchased and imported in some sizes or degrees of process completion than other more desirable sizes or conditions of completion.

3. *Material as an Investment.* In considering the storage of material it should be remembered that material in storage represents money invested. The amount of material kept in storage should therefore be held to as low a working minimum as is possible, and at the same time it should be stored in a manner that protects it from deterioration and abuse. The conditions to be standardized in the storage of material are as follows:

a. The kind of material stored naturally affects the nature of the material storage and incidental equipment relative thereto. Storage racks or containers should be provided that give a definite compartment or position to each kind, size or class of material, and also there

STEEL No. 1020

Heat treatment: one quench; 1575°F for 30 minutes; cooled in oil; reheated for 30 minutes at temperature indicated on curve and cooled in air. (Size treated ½″ – 1½″)



R. A.-Reduction of Area
Y. P.-Yield Point
T. S.-Tensile Strength
El.-Elongation
S. H.-Scleroscope Hardness
B. H.-Brinell Hardness

FIG. 33B. MATERIALS SPECIFICATIONS

should be provided equipment necessary to handle any of the material without loss of time.

b. Equally as important as the classification and storage of material is its proper identification when placed in storage. This identification can be brought about in the following manner:

All material delivered to the material storage should be definitely marked according to quality as well as quantity by the supplier of the material. A standard code for marking material should be adopted and understood by all people using that material, and material ordered for a definite purpose should be marked according to a job or code number reserved for that purpose.

c. Material is required in a definite amount at a given place and at a given time. To meet these conditions the following details must be standardized:

A definite mechanism must be provided for ordering materials from stores; the material ordered should be prepared in the most economical form for transportation to the point of use; and definite transportation between stores and point of use must be provided.

Product. Standardization of a product is essential if all the possible economies of standardized manufacture are to be realized. Some factors involved are:

1. *Mass Production.* Where the entire energies of a plant are concentrated upon the manufacture of a relatively small variety of saleable units the possibilities of economical manufacture are increased. In the case of a plant making a wide range of varieties, styles and sizes, it is readily evident that the plant cannot become expert in making any particular style, size or variety. With the concentration on a few products come manufacturing economies which insure a lower sales price per unit, which in turn will create a larger demand for the article in question.

a. The decision to concentrate on a few products must be based upon the presence or potential presence of a market to absorb the increased production along these lines. One of the chief causes of increased market demand is the presentation of a product at a lower sales price.

b. It has been the experience of factories concentrating upon the production of a few products to find that men and machines working on the same product for longer periods of time have tended to produce economies in manufacture. These economies were found to be the result of greater familiarity on the part of the men with the product produced, special machines that were warranted by the new volume of the product, the devising of new methods in place of old methods, reduction of losses due to errors and lack of understanding, and reduc-

tion of the time spent in setting up, tearing down and making changes in the conditions for operating machines.

c. Where larger quantities of a given material are used by a plant it is possible to get better price and delivery concessions from the suppliers of the material. The cost of transportation of raw material to the plant also becomes less with the increase of volume handled.

2. *Simplification.* The importance of simplification of a product has received considerable emphasis in the United States during the past ten years as a result largely of the efforts of Herbert C. Hoover, Secretary of Commerce. In the reports of the Department of Commerce are found records of remarkable reductions in styles and varieties of the products of various trades and industries. In the same manner the various component parts of the product of an individual plant may be simplified. In simplifying a product special attention is given to the following items:

a. Odd sizes and styles usually find their apparent justification in the minds of salesmen rather than in the net profit they produce on the balance sheet. There should usually be eliminated from a standardized product all sizes and styles which do not show a definite profit value.

b. Continuous use of a product, and this applies particularly to machines, has shown that frequently the design may be altered to produce the same results with fewer parts, with a consequent lower cost of manufacture.

c. The simplification of the operations performed on a piece is another fertile field of standardization. Frequently operations are performed on a piece for no other reason than at some time in the past someone considered this operation necessary. An analytical examination of a product brings to light those operations which are necessary and those which are not necessary.

3. *Variety of Products.* In cases where the product of a plant involves making of several different types of product, each made up of a large number of separate parts, as is the condition of a large number of machine manufacturers, the problem of detail uniformity is important. It is possible that in the manufacture of these various units there are many parts bearing a close similarity to each other, varying only in minor details. The possibility of reducing these many parts to a small number of standard parts will bring out many economies in production.

a. The standardization of these small parts is brought about largely by design with direct reference to the standards adopted. Parts manufactured within the plant in increased quantities make special treatment profitable.

b. The standardization of small parts purchased from outside supplies reduces the styles and varieties of these parts. Careful examination shows that often a cheap standard purchased part may be substituted for an expensive manufactured part.

Methods. By method is meant the manner of proceeding in the performance of work. Methods acquired by chance imitation are usually low in effectiveness; and such methods are also usually wasteful of energy. One of the objects of standardization of methods is the substitution of proved methods for inferior methods.

1. *Predetermination of Performance Standards,* or the outlining of the sequences of processing, occurs at different points in different industries. In most continuous industries the design of the machines determines to a very large extent the methods to be followed in the processing of the product. In intermittent or non-repetitive industries it is possible, where conditions have been standardized to predetermine a procedure for each piece in process.

a. In the predetermination of a method the first step is to provide a skeleton outline of the processes involved in the production of the product. The preparation of this outline is termed "routing." In the continuous-operation machine the routing is a part of the design. In non-repetitive work routing consists of breaking down a product into its constituent parts and determining where each constituent part will be processed. In a standardized factory, data pertaining to the equipment and tools are available which show the processes performed by the various equipments and the capacity of these processes. The paths that the various parts take are determined from the knowledge of these processes and capacities.

b. The determination of the task and the determination of operation details go pretty much hand in hand. In the continuous machine the determination of a task is largely a matter controlled by the speed of the machine. The determination of method details and of a task in the case of a single machine unit operating continuously on the same product is very much the same. However, if the processing involves the handling of the product, the details and the task are dependent upon the nature and time of the manual processes.

The course of procedure to be followed in determining a method for a piece of work varies with the conditions under which the operation is performed. In a repetitive job the quantity of product in use justifies the study of the operation on the part by itself. In the case of a non-repetitive work the operation may have to be studied as applied to a variety of similar operations and the method determined for a class of work rather than for a single piece. Figure 34 shows a page from a classification of operations for a machine tool.

All jobs done on the machine are here classified according to the machining operations done on each piece, rather than by the name or nature of the piece. Then the product is studied by the groups of operations rather than by each individual piece. The method determined is the same within a range of products, although it may take different sizes of tooling equipment.

Figure 35 shows a method card made out for doing one of the operations mentioned above. It will be noted that any size, and consequently

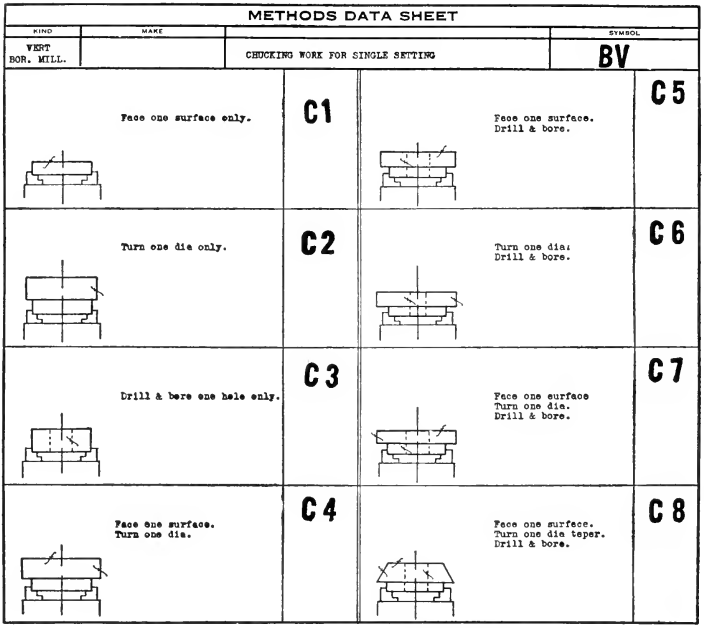


Fig. 34. Data Sheet for Boring Mill

any time, that is a variable is left blank for the detailed insertion of the sizes and times at the time the method is applied to the performance of a definite operation of the type covered.

The non-repetitive job shows the principle that can be applied to repetitive work to secure uniform development of a product. In repetitive work, however, the tendency to study each job as a separate unit and equip for the best production possible on each unit is generally a better plan. This is true as long as this apparent lack of stand-

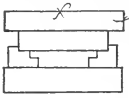
SYMBOL | CLASS C-4 | SHEETS / SHEET NO | METHOD CARD | JOB NO. [redacted] -53

36 BVN C-4

DRAWING & PART NO. [redacted]

SUMMARY

A. PREPARATION
B. FACE SURFACE, TURN DIA
Z. DISASSEMBLE & CLEAN UP



NAME

MAT. [redacted] NO. PCS. [redacted]

TIME ALLOWED [redacted] MACH. 36 BVN

EXECUTION OF A JOB WILL OFTEN SHOW OPPORTUNITY FOR FURTHER IMPROVEMENT IN THE METHOD. SUGGESTIONS ARE DESIRED AND SHOULD BE REPORTED SO THAT IMPROVEMENT CAN BE MADE FOR JOBS THAT FOLLOW. NOTE: WHEN JOB CANNOT BE DONE AS CALLED FOR OPERATOR SHOULD AT ONCE REPORT TO FOREMAN

ITEM	DETAIL FOR OPERATION	TOOLS	FEED	SPEED	MACH & VAR. TIME	FIXED HANDLING TIME
1	A. PREPARATION					
2						
3	Chg T/C, Study B/P & M/C, Arrg Tsd					6.74
4	Eg M. Switch & Start Motor					.18
5	Pl & Set Chk Jaws to ⌀ Dia					2.39
6	Pl & Tls in Vert Head	PR [redacted]				1.14
7	Pl & Tls in Side Head	PS [redacted]				1.35
8	Run Rd[redacted]" by Power					.16
9	Run Cr Rl[redacted]" by Power					[redacted]
10	Run Sd Hd[redacted]" by Power					.12
11	Run Sld[redacted]" by Power					.16
12	Assm & Set Mics to Size	MM [redacted] E				[redacted]
13	Pl[redacted] in Pos.					[redacted]
14						
15						
16	B. FACE SURFACE, TURN DIA					
17						
18	Pl Wk on Tbl[redacted] Lbs, Chg S		[redacted]		[redacted]	
19	True up & Cl[redacted] Wk in Chk[redacted]" Dia[redacted]" Lg				[redacted]	
20	Chg F & S, Turn Turrs		[redacted]			.62
21	Rgh Face[redacted]" Dia[redacted]" Run	PR [redacted]	[redacted]		[redacted]	[redacted]
22	Rgh Turn[redacted]" Dia[redacted]" Run (while face)	PR [redacted]	[redacted]		[redacted]	[redacted]
23	Chg F & S, Turn Turrs		[redacted]			.62
24	Fn Face[redacted]" Dia[redacted]" Run	PS [redacted]	[redacted]		[redacted]	[redacted]
25	Fn Turn[redacted]" Dia[redacted]" Run (while face)	PS [redacted]	[redacted]		[redacted]	[redacted]
26	Remv Wk[redacted] Lbs from Chk, Remv Burrs.				[redacted]	
27	Brush Chips off Tbl.					.31
28						
29						
30						
31	Time for B (lpc) Typed Items =	1.55				
32						
33	Z. DISASSEMBLE & CLEAN UP					
34						
35	Remv[redacted] Paring Tls				[redacted]	
36	Put Tl/L & Tls in Tbx					.47
37	Brush Chips off Tbl					.48
38	Remv & Assm [redacted]					[redacted]
39						
40						
41						
42	Time for A & Z (lpc) Typed items =	13.19				
43	A - Z =	[redacted]				
44	B = [redacted] x Pos =	[redacted]				
45	Total =	[redacted]				
46						
47						
48						

Form No. 640 5-6-27-1M

FORM BY | DATE 7-13-26 | SIGNED [redacted] | DATE [redacted] | APPROVED [redacted] | DATE [redacted]

FIG. 35. INSTRUCTION CARD FOR LATHE OPERATION

ardization results in development of the best methods. In the case of multiple-purpose machines capable of doing a large variety of work on a wide range of products, the predetermination of method details and of the task involve analyzing the separate jobs or classes of jobs into their elementary components in their logical sequence. With the knowledge required for each elementary detail the total time required for a task can readily be determined. The basis for the elementary

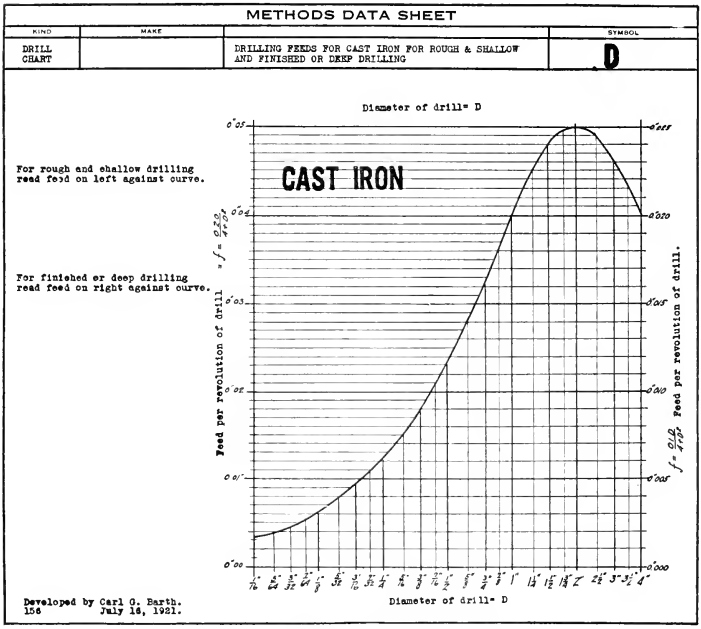


FIG. 36. DRILLING FEEDS FOR CAST IRON

operation time is provided by previous time study of these elementary operations. The determination of the proper sequence of elements is largely a matter of trained habit regarding the use and purpose of these elements. The capacity of a machine to do certain specified work can usually be expressed in some law of output. For convenient use in the predetermination of a task these laws are usually expressed in the form of tables, charts or special slide rules. In Figure 36 is shown a chart for determining the feed per revolution of twist drills drilling in cast iron.

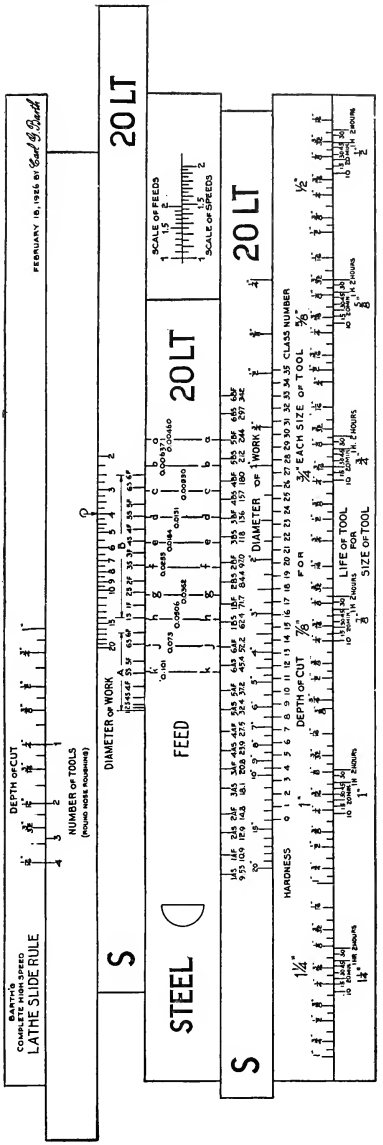


FIG. 37. BARTH SLIDE RULE FOR TURRET LATHE

In Figure 37 is shown a Barth slide rule used in determining the feed and speed on a turret lathe. By means of this rule the solution of any problem of cutting in steel can be solved. Figure 38 is a chart showing data pertaining to the chasing of threads on an engine lathe.

c. At the same time a determination of the elementary details of a job is made, the tools required in connection with each job are listed

METHODS DATA SHEET

KIND	MAKE		SYMBOL
PARING TOOLS	ARMSTRONG CORK CO.		PVV

ROUTINES:- (a) Add to actual length of thread, amount shown in table #1,make solution on slide rule for total length, obtain time for one cut. (b) Add time for running carriage, see table #2. (c) Multiply number of cuts, see table #3.

Threads per inch.	Amount to be added.	Actual length of thread in inches											
a- CUT EVEN THDS, as 2,4,6,	1/2"	To any length thread.											
a- CUT ODD THDS, as 1,3,5,etc	1"	To any length thread.											
a- CUT THDS ENDING IN 1/2, 1-1/2, HALVES AS 2-1/2 etc.	1"	To any odd length thread.											
	2"	To any even length thread.											
a- CUT THDS ENDING IN QUARTERS, AS 1-1/4,1-3/4,2-1/4, etc.	4"	4	8	12	16	20	24	28	32	36	40	44	48
	3"	1	5	9	13	17	21	25	29	33	37	41	45
	2"	2	6	10	14	18	22	26	30	34	38	42	46
	1"	3	7	11	15	19	23	27	31	35	39	43	47
a- CUT THDS ENDING IN EIGHTS AS 1-1/8,1-3/8,1-5/8, etc.	8"	8		16		24		32		40		48	
	7"	1		9		17		25		33		41	
	6"	2		10		18		26		34		42	
	5"	3		11		19		27		35		43	
	4"	4		12		20		28		36		44	
	3"	5		13		21		29		37		45	
	2"	6		14		22		30		38		46	
	1"	7		15		23		31		39		47	

TABLE NO. 1

For computing time on slide rule.

	Machines	Carriage manipulation to out various length threads.											
		4"	8"	12"	16"	20"	24"	28"	32"	36"	40"	44"	48"
RUN CARR & SET FOR NEXT CUT.	16 LE	.18	.20	.21	.23	.25	.28	.30	.32	.34	.36	.39	.41
	18 LE	.18	.19	.21	.23	.25	.27	.29	.31	.33	.35	.37	.39
	18 LB	.18	.19	.21	.23	.25	.27	.29	.31	.33	.35	.37	.39
	19 LE												
	20 LE	.18	.21	.23	.26	.28	.31	.33	.36	.38	.41	.43	.45
	24 LE	.19	.22	.24	.28	.31	.34	.37	.40	.43	.46	.49	.52
	24 LE												
	24 LE	.20	.23	.28	.32	.36	.39	.43	.46	.50	.54	.57	.61
	30 LE	.22	.26	.33	.37	.41	.45	.50	.55	.60	.65	.70	.75

TABLE NO. 2.

Back tool out, disengage half nut, run carriage back to start cut, engage half nut.

CHASE__THRDS__"DIA__CUTS (Element to be used for methods card)

FIG. 38. DATA FOR CHASING THREADS ON ENGINE LATHE

for the purpose of forwarding an order to the tool storage to supply these tools at the time wanted.

d. In order that a predetermination of a performance may retain its value for future reference it is customary to place the predetermination in the form of a definite record. This record is referred to in the predetermination of method of a similar product or is used again in the case of repetition of the original product.

2. *Supplementary Standards.* Standardized methods in operation require a correlative condition of a number of functions and physical

units in the performance of a particular operation on some unit of product. The result produced is the consequence of actions previous to and during the operation. The most important of these actions are those previous to the operation.

a. Preparation of conditions previous to an operation contributes materially to the results in performance of the operation. This means that all material, equipment, tools and detailed instructions are at the processing point at the time processing is to begin. The failure of any factor results in inability to perform. In a continuous machine preparation consists of a supply of raw material ahead of the first point of process and requires that each process successfully feed the process following it. In non-repetitive processes preparation involves the presence of all physical factors necessary for the performance of the operation.

b. Another factor particularly important is the presence of exact and detailed information regarding the product to be made. In continuous or repetitive industries the personnel become trained in the particular function they are called upon to assume, with the result that it may not be necessary in each case of repetition of the operation to refer to the detailed information in order to produce an accurate product. In intermittent or non-repetitive industries, the frequent changing of the product makes it almost impossible for the personnel to retain the details of the product in mind. In this class of work detailed instructions regarding what to make and how it is made are important aids to making the product quickly and accurately.

c. One of the important methods factors in operations is realization of the relative importance of the various details of the product; the ability to size up a job to see that no more work is put on a part than is necessary for the performance of its function.

d. The development of trained habit in the performance of operations is essential to the attainment and maintenance of high methods standards. This means that the personnel must become trained to perform the various mechanical operations as a matter of habit. This leaves the mind free and alert to cope with accidental difficulties arising in the processing. In continuous or repetitive industries trained habit is one of the natural results of continuous performance on a task. In the intermittent or non-repetitive industries, trained habit is developed through the performance of certain elementary operations which are continuously being duplicated over a wide range of products.

3. *Performance Records.* The by-product of the use of good methods is the accumulated record of good performances. With the record of good performance on file it is easy to refer to this record and maintain performance. In the same manner, with a definite method

of procedure to criticize, it is possible more readily to create a better and more economical procedure for the performance of the same task.

Records of operation performance are kept for future recurrence of the same operation as are also records of group performance.

A record of man performance is kept as impartial information regarding the value of a man to himself, to his fellow associates and to his company. Regardless of the type of industry involved, a record of accumulated performance furnishes a basis for predetermination of future performance and a record of the points which may best be approached with the object of improving the methods in use at these particular points.

Accomplishments. The purpose of all standards so far described is to aid in the development and maintenance of standards of accomplishment. The standardization of small details to uniform performance results in uniform accomplishment when the detail standards are properly coordinated. The coordination of these details is covered in another chapter.[1] In this manner standards of accomplishment become a measure of management, a yardstick by means of which the results of man, machine, department or plant can be compared.

1. *Standard Times.* By the use of the standard operation times, as developed in the predetermination of methods and tasks, a predetermination of the total time to produce a part is developed. By means of this time the equipment necessary to produce the product at a definite rate, or the production rate with existing equipment, can be determined.

The computation of a production schedule depends upon the time consumed in processes and between processes. Both of these classes of times in a standardized plant are covered by standard times. In a continuous or repetitive industry the daily production is of more importance than the time elapsed from the start to the completion of the piece. In an intermittent or non-repetitive plant, the elapsed time in process is a highly important factor in the operation of a production schedule.

2. *Standard Costs.* With factory operation standards in effect it is also possible to determine standard operation costs which will be accurate to a surprising degree. Thus, knowing the detailed costs of a certain production schedule, the costs charged to the various accounts can be budgeted into standard controlling accounts. This feature makes possible the control of the expenditures involved in factory operation.[2]

3. *Quality Standards.* The application of standards to every activity in a plant brings about a definite means of determining any

[1] Cf. Chapter XXII.

[2] Cf. Chapter XXVI.

factor in the operation. With guesswork practically eliminated, the product takes on a higher quality standard. In fact, it is impossible to have a product associated on all sides with standards of a high degree of equipment, materials and performance without that product partaking of the excellence of the association.

4. *Low Costs.* Another accomplishment that is the result of standardized plant operation is the fact that the product is produced at a cost that permits sale at the market price with a profit.

5. *Wage Standards.* A standard of accomplishment of factory operation that affects the personnel of a plant to a greater degree than the plant or its management is the ability of a standardized plant to pay higher wages than one lacking in standardization. A few reasons for this will be given. In the first place, the development of a task of performance can now go hand in hand with a wage incentive for the performance of that task within the standard time set. In the second place, a man working under standardized conditions does not have to look after the preparation of the details of his job, but is free to concentrate upon the perfect application of his trade ability. With the increase of trained habit along a higher plane, a man commands a higher rate because of his ability to do more things. In the third place, the association of a man with high quality and performance standards helps improve the mental capacity and ability of that man. With the proper commercial approach these improvements are converted into a higher total wage. Finally, the training which a man gets under standardized conditions working with standard methods to meet standard tasks, is the best training ground to enable a man to cope with the civic and economic conditions in his community. Leadership thus developed is rewarded with more responsibility within the plant itself or in the opening of opportunity elsewhere.

In present industry there cannot be a standard wage for all communities, all industries and all crafts. But in a particular plant where, because of standardization of conditions, there is with respect to each operation precise knowledge of the quality of craft skill and the performance time required, operations may be classified by standards of wage payment in terms of the base for each craft, worked out by social forces in the community. And for the reasons stated above, the standard wage rates will be higher than the community rates for corresponding crafts and operations.

6. *Standards and Human Relations.* The last standard to be mentioned under accomplishment is the standard of human relationship. This standard is purely a relative one and cannot be measured with any hard and fast rule. It is based upon the fact that in scientific management the greater portion of transactions within the plant are upon

a basis of fact rather than upon a basis of guesswork or opinion. Under these conditions the feeling produced in a man by the knowledge that he will be judged by standards which are open and available to everybody is one of satisfaction and contentment. Satisfaction and contentment, however, are not to be construed as stagnation and complacency. The condition is characterized rather by an alert desire to cooperate and advance.

Standards are an aid to the determination of the proper requirements of a job, and knowledge of the amount of work to be performed on a job renders it easier to determine the qualifications of a man to fill the job. Also, in the same manner, the definite record of production by a man makes a direct rating of his ability to produce in his particular job.

Factory operation standards are of value only as long as they are maintained. It is a human characteristic to follow the line of least resistance and be satisfied with something slightly poorer than the best, and if this characteristic is allowed to act there will be a sloughing off in the quality of standards. With the fall of the standards comes a similar decline in accomplishment and personal responsibility. The cycle repeats itself until the condition of the standards reaches a level slightly lower than the desires of the man in a rut. Eternal vigilance is required to maintain standards.[1]

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[1] Cf. Part V.

CHAPTER XVI

LABOR STANDARDS [1]

THE effort to establish operating standards in the several functional departments of an organization should logically not stop until standards are set throughout the field of personnel activities. But the difficulties of deriving objective standards in this field are such that the definitions which can be made at this time are really suggestive and prospective rather than closely accurate.

The range of activities for which standards have to be found is so extensive and covers so many lines of effort in which experience has not as yet suggested a valid criterion, that a statement of what standards are needed is almost as far as one can go. The conspicuous exception to this statement lies in the field of selection where much work along this line has been done. This may well be drawn upon in order not alone to suggest how standardization is progressing there, but also to suggest the kind of attack which must and can be made toward the setting of standards in the other personnel functions. From the point of view thus set forth, it should be possible for the reader to see how in the fields of training, health and safety work, and the other activities, the idea of deriving new standards can gradually be followed through.

First, however, certain general considerations should be presented as a background for the subsequent discussion.

Principles of Labor Standardization. Individuals of every type of labor seek to attain certain human satisfactions and so far as possible to obtain them with the minimum of effort. The strength of the motivating desire in a measure corresponds to the degree of effort put forth. The effectiveness of the effort appears in the products of that effort. Human energy not properly applied produces results poorer in quantity and quality than are produced when it is efficiently coordinated and applied.

Labor loss is increased when there is a sense of dissatisfaction resulting from misapplied energy or from other causes. Proper adjustment to kinds of work, as well as skill, is thus essential in producing the best. This adjustment involves a determination of the capacities of the individual and of the types of capacities that find satisfaction in different kinds of work. The problem is complex. In its simplest

[1] By C. S. Yoakum, Dean of the College of Liberal Arts, Northwestern University, Evanston, Ill.

form it involves analyses of the abilities of each individual and of types of work to be done. To obtain a successful combination demands not alone that the best ability of an individual, or the best individuals, be considered, but that those abilities be used which, when applied to the task, result in continuous satisfaction. A task that requires average intellectual ability will often be badly performed by one of great ability or by one of little ability. Each of these will be maladjusted and dissatisfied. The increasing use of mechanical means of production only makes more important the requirement of the right human adjustment at each job.

The fundamental principles of labor standards rest on the above considerations. That individual engaged in work who feels that results are commensurate to his efforts, and who finds his satisfactions in line with his ambitions, is well placed. This condition is concretely expressed in terms of individual and group production. Questions of quantity and quality of finished product are discussed in other chapters. Yet to enable the industrial psychologist or employment executive to proceed with his work, these standards must all be expressed somehow in terms of human behavior.

But human behavior is a variable. It is characteristic of man that he can exist in a wide range of conditions. This fact must be kept in mind throughout the following discussion. This particular capacity is commonly spoken of as adaptability. In addition to being adaptable and variable within wide limits, he varies from his fellows. This fact of individual differences supplies the basis for the mental measurement efforts which have been rapidly extending in recent years.

Individual variability lies in the foreground of many problems of labor relations. The total situation in which a man works may make many changes in his attitude that are unaccounted for by the simple measurement of his individual capacities. In what follows, therefore, we shall speak of measurement and analysis of capacities, knowing that the particular individual or group has not been entirely stabilized by our best efforts to place him in the right vocation or position.

The process of establishing labor standards involves consideration of the man, his tools and his job. We are concerned here primarily with those techniques which are used to analyze the first of these—the man. The criteria of successful existence as a worker, and of making a profit in money and satisfaction, must be met coordinately with the standards dictated by the man analysis. Discussion of these will be found in the chapters on personnel planning and control, labor standards and employer-employee relations. These other criteria thus set up become the second term in the mathematical equation which we

must solve. The first term comprises the body of facts we can discover by studying the man.

Methods of Analyzing Human Capacity. Methods for analyzing human capacity are relatively new. The psychological laboratory is scarcely fifty years old. The highly complicated nature of man has thrown many difficulties in the path of the research worker in this field. Even so, it is surprising to note the rapid increase in use of laboratory methods. Attempts to apply the results of these methods are still more recent. Münsterberg began his studies in applied psychology almost forty years after Wundt established the first laboratory in 1874. The World War hastened the interest in human capacity and gave opportunity to test certain findings of the laboratories on a large scale.

1. *Capacity Tests.* The testing program from which labor standards can be derived may be conveniently presented in two major divisions. There are first those tests and analyses which seek to determine the capacities of an individual or group of individuals. These capacities or abilities or aptitudes indicate fields in which individuals are most likely to become proficient, be successful and be satisfied. The standards so derived will necessarily be rough standards unless the capacity called for by a job is highly specific. They are, however, important as indicators of the probable future value of the individual as an employee. These inherent ability analyses are sometimes grouped into general ability standards and special aptitudes.

The most frequently tested ability is commonly called intelligence or intellectual ability, the ability to understand, to learn, to profit generally by experience. Tests which attempt to determine the relative amount of this ability have been variously called psychological tests, intelligence tests, mental alertness tests or simply general ability tests. Other general abilities on which attempts at analysis and measurement have been made are mechanical ability, social ability—the ability to get along with others—emotional status and temperament and character or moral status.

The group of special capacity factors to be examined in the effort to establish standards is usually referred to as special aptitudes. Outstanding examples of these are often found in the arts, such as music, painting, sculpture. Others that may be mentioned are special memory for numbers, ability to calculate rapidly, various mechanical aptitudes. These are often found necessary for success in certain jobs or parts of jobs, so that it is frequently profitable to devise tests for departments of a business or industry and for specific jobs.

2. *Proficiency Tests.* The second major division of a testing program is the measurement and building up of standards for proficiency.

These are commonly grouped with educational attainment or knowledge tests and trade tests. Each group is intended to indicate the amount of information and degree of skill available in those persons who claim previous training and experience.

3. *Construction of Tests.* The techniques for building the various tests must be thoroughly understood. Briefly, a test must contain interesting material or the individuals tested must be properly motivated prior to and during the testing process. The content of the test may be built out of material related to the subject's knowledge or work, for the general ability tests. For the others the content of the test will more naturally bear on their interests, special abilities and occupations. It must be given under conditions as natural as possible. Reasons for it should be clear and unequivocal. If given to groups of employees, result should not alter existing conditions except as a standard for accessions and layoffs in the regular course of employment. The reliability of the tests should always be known; that is, whether a given test when repeated would give similar results or not. Scoring procedures should be so standardized that persons scoring the examination papers independently will obtain like scores. The above techniques are important in preparing the test.

4. *Validity of Tests.* The fundamental requirement of a test is its validity. Does it select the persons who are fitted for the work? Does it rank workers according to their ability to do the work? Will it predict?

Mathematical calculations are necessary to determine reliability and validity. Suppose these indicate satisfactory results. Shall we use the test in selection and placement? There may be more expeditious and cheaper methods available. Usually these will not produce objective labor standards such as are available from a valid test. If such standards can be established without the use of any form of test and be used more rapidly and more cheaply the test would be superfluous. A successful test must increase our success in the accurate handling of the employment process.

Mental Alertness Tests. Mental alertness tests have appeared in numerous forms since the war period. The majority have been devised for testing numbers of individuals in groups. Most of them can, however, be used to obtain data of value in individual cases. As an illustration of a simple type, we give here the instructions and sample questions from Bureau Test VI. (Figures 39 A and 39 B.) This test is based on Army Alpha, the test used in the selection and placement of recruits in the United States army during the war. It does not use Parts 1 and 3 of the army test. Instead of keeping the items or questions in groups, the questions are mixed or "scrambled." The in-

DIRECTIONS

Inside this booklet you will find a lot of things to do. Samples of all the different kinds of things to be done, are given below. Read the samples and directions carefully.

(a) How many men are 5 men and 10 men? Answer (15)
Write the correct answers to such problems, as indicated.

(b) good—bad **same—opposite**
The words "good" and "bad" are opposite in meaning, and the thing to do, therefore, is to underline **opposite,** thus: good—bad **same—opposite**

little—small **same—opposite**
The words "little" and "small" mean nearly the same thing, and, therefore the thing to do is to underline **same** thus: little—small **same—opposite**

(c) a eats cow grass **true—false**
These words can be arranged to form a sentence, as follows:
a cow eats grass.
This is a true statement. Therefore the thing to do is to underline **true,** thus:
a eats cow grass **true—false**
Do not write the sentence.
horses feathers have all **true—false**
In this case, the words, when rearranged, make a false statement:
all horses have feathers.
Therefore, the thing to do is to underline **false,** thus:
horses feathers have all **true—false**

(d) 2 4 6 8 10 12 ....
If the plan in this series of numbers were carried further, the next two numbers would be **14** and **16.** Therefore, the thing to do is to write **14** and **16** in the two spaces provided, thus:
2 4 6 8 10 12 ..**14**.. ..**16**..

1 7 2 7 3 7 ....
To carry out this plan you should write **4** and **7** as the next two numbers, thus:
1 7 2 7 3 7 ..**4**.. ..**7**..

(e) sky—blue :: grass—**table green warm big**
Here the thing to do is to underline the word that is related to "grass" in the same way that "blue" is related to "sky." Blue is the color of sky. Therefore, **green** should be underlined, because the color of grass is green, thus:
sky—blue :: grass—**table green warm big**

Monday—Tuesday :: January—**year November Sunday February**
Tuesday comes next after Monday. Therefore, February should be underlined, because it comes next after January, thus:
Monday—Tuesday :: January **year November Sunday February**

(f) People hear with the **eyes ears nose mouth**
Here the thing to do is to decide which of the last four words makes the sentence a statement of fact, and underline it, thus:
People hear with the **eyes ears nose mouth**

When the signal is given, begin at top of the next page and work through the remainder of the booklet.

Work rapidly. If you are not sure about something guess at it, and go on to the next thing. There are no "catch" questions.

Do not ask questions. You are at liberty to refer to the directions at any time, but to do so oftener than necessary will waste time.

You will be allowed **fifteen minutes.** You probably will not be able to finish in the time allowed but do as much as possible.

Do not skip about. Items skipped will be counted wrong.

Do not turn over the page until the signal is given.

FIG. 39A. EXAMPLE OF MENTAL ALERTNESS TEST

structions are written out in full and read through completely before the subject writes any answers. Practically no writing, beyond a few numerals, is required. Four minutes is allowed for reading the instructions. When the group is unfamiliar with such tests a longer time may be permitted. The test may be given and standardized with or without time limits. Best results seem to be obtained in this case by the use of time limits.

Tests similar to these will usually be found useful as a preliminary in any group survey of applicants or workers. The data are easy to obtain and can in many cases be with profit made a regular part of the employment routine, provided they are administered by people thoroughly trained in their use. In conjunction with special ability tests and the trade test they can gradually be formed into labor standards of great value.

Begin Here!

(1) How many are 50 tents and 8 tents? **Answer** ( )
(2) white—black **same—opposite**
(3) bird—sings :: dog—**fire barks snow flag**
(4) dogs meat eat **true—false**
(9) 2 3 4 5 6 7 ....
(11) The Merino is a kind of **horse sheep goat cow**
(178) cardinal not cultivated virtues the be should **true—false**
(179) 4 8 10 20 22 44 ....
(180) pertinacious—obstinate **same—opposite**
(181) advice—command :: persuasion—**help aid urging compulsion**
(182) A commission house which had already supplied 1,897 barrels of apples to a cantonment delivered the remainder of its stock to 27 mess halls. Of this remainder each mess hall received 56 barrels. What was the total number of barrels supplied? **Answer** ( )
(183) A **five-sided figure** is called a **scholium pentagon parallelogram trapezium**

FIG. 39B. EXAMPLE OF MENTAL ALERTNESS TEST

In certain instances, such as clerical work of all grades, some type of mental alertness test has thus far proved to be the best single criterion. As a measure of learning ability under every variety of condition, it seems to be the most generally reliable test. As a standard to parallel increasing complexity in a series of positions, it comes nearest to predicting those who will drop out because of the greater difficulties involved.

This relation between average test score and classification of the job on the basis of complexity can be seen in the following table (Table 6). Grade C is largely composed of an emergency group of workers, many of whom were slated for promotion at the time the tests were given.

When compared with ratings of supervisors it is found that in general those clerical workers making the higher intelligence scores receive

TABLE 6[1]

AVERAGE TEST SCORE AND CLASSIFICATION OF JOB

Grade of Work	*Average Score*
A (Office Boys)	52
B	91
C	118
D	102
E	107
F	113
G (Supervisory)	130
Typists	90
Stenographers	106
Secretaries	120

superior ratings on efficiency. Two things occur with respect to permanency of service. Persons who make high scores on the test remain if their promotion is fairly rapid or assured. Those who test low and yet are hired for relatively complex jobs fail to give satisfaction and are quickly dropped from the force.

Precisely similar results were found by the use of a test of the same general type in factory work. In a department where the job specifications indicated need for average intellectual ability in addition to skill, workers with low mental test scores and those with high test scores both showed higher turnover rates than those with intermediate test scores. In another department both average and high score workers presented high turnover rates. In a third department the highest turnover rate occurred among those of average score. A study of the job specifications of this department showed that it contained two types of work, one involving routine operations and another calling for a large amount of diversity of response, perceptual discrimination and judgment. In the above cases several different optimum scores would become the standard as to the amount of mental alertness required in applicants.

These brief illustrations present principles familiar to any one who deals with job specifications, with materials' specifications, with standards of inspection, and so on. Objectives are set up, such as ability to do the work, a range of efficiency in doing it, a certain degree of permanency, the possibility of promotion to greater degree of responsibility (more complex jobs) and satisfaction of the individual at work. The tests and other methods of selection and placement are invented, investigated and standardized with reference to attainment of those objectives which are deemed most important.

[1] Adapted from Table 2 in "Psychology in Business," *Annals of the American Academy of Political Science,* Vol. CX, 1923, p. 65.

Special Aptitude Tests. Within the standard ranges of general ability, whether these ranges be determined for intellectual, mechanical, social or temperamental capacities, it is often valuable to seek for special aptitudes with reference to individual jobs. In certain cases, such as musical talent, the analysis shows the special aptitude to be a highly complex group of special abilities. In other cases one or more relatively simple factors suffice to place the operator high among his fellow workers. We present one of these simpler operations to illustrate the procedure.

The test is one of finger dexterity. The workers, largely women, are assigned to fine meter or instrument assembly work. The test was standardized on 1021 women, during a period of three years.

SPECIFICATIONS FOR APPARATUS [1]

Use three hundred brass pins, 0.072 inch in diameter and one inch in length; and a metal plate seven-eighths of an inch in thickness, five and three-fourths inches wide by twelve inches long. In one half of the plate drill one hundred holes, arranged in ten lines of ten each, one-half inch apart both ways; depth of holes, three-fourths of an inch; diameter of holes, 0.196 inch (No. 9 drill). The other half of the plate consists of a shallow tray approximately five by six inches with gently sloping sides so that the pins cannot be lifted by gathering them against the side of the tray.

DIRECTIONS

Show candidate the pin board with three hundred pins assembled, three in each hole. Say: "There are three pins in each hole. I will tip them all out and get you to put them back, three in each hole, as fast as you can. Use only your right hand. Try to pick them up three at a time because you cannot go fast enough taking them one by one." Allow candidate to place thirty pins, thus filling up ten holes for practice. Tip out these thirty again, allow a moment's rest and then time accurately with a stop watch in minutes and hundredths of minutes the time required from placing the first pin to the last. If either two or four pins are assembled by mistake in one or two of the holes do not count against the candidate, and if because of such a mistake two or three pins are left over at the end do not require the subject to find where these pins belong and assemble them. The test measures finger dexterity, not accuracy in counting.

The percentiles based on 1021 women and 158 men are:

Rates	*Women*	*Men*
Fastest speed	5.70 minutes	5.70 minutes
25 percentile	7.10 "	7.70 "
50 percentile	7.70 "	8.30 "
75 percentile	8.30 "	9.00 "
Slowest speed	over 15 "	over 15 "

[1] Hines, Mildred, and O'Connor, Johnson, "A Measure of Finger Dexterity," *The Personnel Journal*, Vol. IV, 1925-1926, pp. 379-382.

Seventy-seven women engaged to do fine meter or instrument work distribute themselves as shown below after being given full opportunity to succeed at the tasks:

TABLE 7

Quartiles Based on 1021 Cases	*Scores*	*Percentage of Successes at Actual Work*	*Percentage of Failures at Actual Work*	*Percentage of Terminations Including Failures*
1.....	0 −7.10	88	0	12
2.....	7.11–7.70	89	0	11
3.....	7.71–8.30	50	29	50
4.....	8.31 or more	40	40	60

The writers say further: "Regardless of whether or not one believes in tests of this character, the employment manager who has among his selections no failures and 11 or 12 per cent leaving, is more successful than one with 29 to 40 per cent failures, and 50 to 60 per cent leaving. This result can be accomplished by selecting applicants who score above the median in such a test as this." Subsequent use of the test in selection has shown the validity of the standards thus established.

In the laboratory, the psychologist has developed numerous special measures designed to analyze the various mental factors. Experimental procedures are available for analyzing such characteristics as motor capacities, sensory processes and learning, perception, memory, reasoning, ingenuity and imagination, temperament, character. But few of these have yet been adapted to practical industrial use. Undoubtedly all of them will gradually find a place in the development of labor standards in many types of work. Methods of formulating job specifications do not as yet readily lend themselves to the type of analysis necessary to specify the particular mental process or group of processes essential to a specific task.

Two of the most interesting of recent attempts to analyze and adapt measures of human capacity to vocational adjustment are the interest analysis test and the social relations test. The first undertakes to show by individual responses to a large number of ordinary life situations that the reactions of persons successful in one of the professions or trades are significantly different from the reactions made by one in any other trade or profession. The social relations test endeavors to segregate those factors which make for easy and successful adjustments between individuals. Both specialized types of test show promise of eventually being useful additions to the general labor standardization program.

Information and Skill Tests. In contrast to the above types of tests the trade test and the information or knowledge test seek to de-

termine the degree of skill or the understanding of the processes performed. Tests of these kinds would, in the above example, be based directly upon the work done by the seventy-seven women actually on the job. If applicants claimed previous experience, the tests would be applied to determine the degree of skill attained and the extent to which the applicant understood the work to be done. Such tests are designed to measure acquired abilities.

The types of trade tests are oral, written and performance. Any one of the three may be used to gauge either the skill or the knowledge of the candidate. If skill is to be judged, use of the oral and written tests is based on the close relationship which exists in most cases of expertness between knowledge about the job and the ability to do it. Such a statement is, of course, limited in its application primarily to skilled trades and to candidates who claim experience. It was found, for example, that performance tests only would give a safe estimate of the truck-driver's skill. The knowledge tests have been most highly developed in the United States within school systems or in corporation schools.

Such tests are difficult to construct. The limits of validity and accuracy are more closely drawn than in the case of capacity tests. This fact indicates, not that it is a simpler task to construct general and special capacity or aptitude tests, but rather that we know less about the mental aspects of the criteria with which they should be compared.

A further difficulty arises in respect to trade and specific information tests. Trades in general have fundamental principles, but the modifications of them in different factories and to different materials make it hard to construct a test free of the peculiarities of the specific job. If successful in this latter respect the test may fail of its special purpose of enabling the employment manager to select men fitted for jobs within his plant. Probably the best solution of this difficulty lies in the cooperation of industrial concerns in building their job specifications and in setting up standard requirements on the basis of tests also constructed cooperatively.

The problem is largely one of developing the necessary skill in the preparation and standardization of these tools. Considerable acumen is also essential if time and money are not to be wasted in working on standardizing data for departments which can be left to the last. An ambitious program can easily fall to the ground under its own weight. Improperly started it will engender more hatred and opposition than almost any other action of management. One of the simplest illustrations of this occurs in giving a test involving language or terms not thoroughly familiar to the subjects. Picture tests and non-verbal tests of several types have been devised to meet this diffi-

culty. Some of these do not require the use of verbal language on the part of either the tester or the testee. The introduction of a labor standardization program should proceed with the most obvious competitive devices in the beginning. Those used should be so carefully prepared that they can be handled by men well known to the candidates, such as foreman, assistant foreman and the workers themselves.

Other Devices. Three other devices have been used in developing standards for employment and placement; the personal record, the interview and the rating scale. These devices collect less objective data considered of value either as records or for the process of placement. They do not admit of the same type of standardization as do tests. However, the personal touch that is lacking in tests is supplied in these more intimate records. It is important, therefore, to determine as accurately as possible the significance of the data collected by these forms.

1. *The Personal Record.* Practically every company makes use of some form of application blank or personal record form for its employees. It may contain a few simple matters such as age, marital status, previous experience and education, or it may have dozens of items. Such forms are usually the product of what some particular employer thinks he wants to know about an applicant, rather than the result of careful investigation of the significance of various items of information. A standardized program of selection demands that each item on the application form shall have some value, some demonstrable significance in separating good prospects from poor. Indeed every item, whether in regard to mental characteristics, interests or character, should prove its usefulness in separating the wheat from the chaff.

An illustration of the composite photograph obtained from a study of personal history items furnished by insurance salesmen shows the final steps in evaluating such a form. The multiple correlation figure obtained from combining a portion of these data and production records is +.40.

The average life insurance salesman who filled out the questionnaire is in his thirties; is five feet, nine and one-half inches tall; is married at the time of contract; has two children; has gone to high school or college; has been out of school about fifteen years; has had four previous jobs; is apt to have been in insurance, the professions outside selling, clerical work or in business for himself before beginning to sell insurance; has stayed about seven years in some one of his previous positions. He belongs at present to three or four clubs, is a member of a church and usually holds one office. He has been selling life insurance from five to six years. He has had about one year's expe-

rience selling products or services other than insurance. He carried $3000 insurance when he came with the company and now carries about $9000.[1]

If we assume that application forms are only filled out completely by those applicants who appear, on the basis of an interview, to be worth hiring, these records may serve as valuable sources of future labor supply and also as checks against reapplications. It is understood, of course, that the validity of these records as a basis for selection can only be established by performance records of the employees over a considerable period on the job. These subsequent records on the job become the really informing personnel records.

2. *The Interview.* The interview has not thus far been successfully standardized. The literature of employment methods is full of general discussions relating to its place in the process and many shrewd observations are made relating to procedures. It would take us too far afield to bring together here anything of value to the establishment of labor standards. Researches now in progress should, however, greatly improve the technique of the interview and finally enable us to standardize certain aspects of it.[2]

3. *The Rating Scale.* Much work has been done in the attempt to increase the reliability and the validity of the rating scale. This instrument is used in some form in all those instances where records are desirable, but the data do not readily lend themselves to quantitative and objective statements. Numerous forms of scales have been developed. The form probably most extensively used is known as the graphic rating scale.

An illustrative item from one such scale is given below:

1. How does his appearance impress you especially his facial expression, physique, carriage, and neatness?

Creates fine impression	Good appearance	Appearance satisfactory	Gives somewhat unfavorable impression	Makes a poor appearance

Instructions to the rater are: "Read and consider carefully all the descriptive statements under the line before attempting to record your opinion. Indicate your opinion on each quality by making a cross (X) on the line just where you think it ought to be. For example, if in Quality 1 you think the prospective salesman is a little lower than indicated by the statement 'appearance satisfactory' but not quite low

[1] Prepared by Dr. Grace E. Manson. Used in Kenagy, H. G., and Yoakum, C. S., *The Selection and Training of Salesmen,* New York, McGraw-Hill Book Company, 1925, p. 241.

[2] Bradshaw, Francis W., "The Interview: A Bibliography," *The Personnel Journal,* Vol. V, 1926, p. 100.

enough to be recorded 'gives somewhat unfavorable impression,' then put the cross on the line somewhere between these two points."

Such a scale can be treated statistically in a variety of ways. The qualities may be weighted in any manner desired, or they may be used simply for general comparison without being quantified. If one wishes to treat the data numerically, each line may be measured from the left to the position of the cross by a ruler divided into as fine divisions as are desirable.

Numerous cautions must be observed in the construction and use of such a scale in order to give it any validity whatever. Although both reliability and validity are never high, the scale is an excellent means of giving permanent form to one's impressions and opinions. Where several persons act as judges and fill out blanks independently, reliability will be increased. It also offers a means of comparing judges who, if they happen to be supervisors, foremen or department heads, are then themselves rated on ability to judge others.

The rating scale is an illustration of an instrument which can be used both in the process of prediction for selection and placement and as a part of the employment record. Obviously it should not be solely relied upon where objective data in the form of tests or production records are available. Its use lies in recording impressions and opinions on qualities of behavior for which no objective techniques of measurement exist.

4. *Training Records.* In many business and industrial companies an intermediate stage for the employee has grown up either between employment and beginning production, or before placement, or as a preliminary to promotion. This is the training period. During this stage of adaptation of the employee, records of his proficiency in learning, of his probable aptitudes and interests, are usually kept. From these data assignment to duties takes place on more intimate information concerning capacity than where the employee is placed immediately upon hiring, or transferred without preliminary training.

Under these conditions all of the standard measures above described must be adapted so that they will throw light upon probable progress during the learning period as well as predict degree of success when finally placed. The training period is in itself an excellent criterion of future production, provided essential records of progress are carefully kept. Nevertheless, training is an expensive period of nonproduction. It is important to reduce it to a minimum. Hence the use of all standards having a fair degree of validity, in assigning individuals to appropriate training courses, is justified.

General Considerations. A successful and useful labor standard is one that correlates with performance. The necessity for adequate

performance records becomes obvious. But performance records which actually group employees into reliable groups according to satisfactory service are difficult to obtain. No single form of measure has thus far proved statistically reliable. Numerous criteria of success have been tried and in separate instances certain of these seem fairly useful. Foremen's ratings; various forms of production records, including total pay received, amount of bonus, quantity produced, quality; point systems of weighting results; terminations or length of service; and rate of advancement, have been used singly or in various combinations.

Difficulties in the use of ratings have been noted. Questions arising in the use of production figures include different conditions of work, different degrees of experience with machines and materials, motivation of the worker, customary limitation of output, and so on. It is true these do not affect the establishment of production standards in bulk, but they do seriously affect correlations between test results and individual production figures. A few terminations may be definitely due to unsatisfactory work, but labor turnover figures of themselves lack that reliability essential to a true criterion. Permanency or length of service is somewhat better, yet it too is complicated by transfer and promotion to new operations which may not have appropriate test records with which to compare. It is also essential to know the relative importance of the several criteria of success if a combined score is sought.

Illustrations of the solutions that have been attempted would require too much space. Enough has been said to show that rough and ready judgments cannot be relied upon. Scientific management in trying to build up labor standards must be ingenious, scientific and persistent. A noteworthy sample of such a procedure is cited in the reference given below.[1]

All factors considered above are also strongly affected by the environment of the employee. This environment includes his home and community surroundings, his physiological and emotional status, and the physical conditions in which he must work. It is not within the scope of this chapter to discuss these important features of labor standardization. Unless a favorable condition exists, however, with reference to these factors, attempts to develop the standards here described will amount to little. Wide variability exists in such simple items as eyesight, hearing, muscular power, nervous tension. Disease, improper foods and unsuitable working conditions reduce the effectiveness of the worker. Moreover, unless these various factors are known

[1] Pond, Dr. Millicent, "Selective Placement of Metal Workers," *The Personnel Journal*, Vol. V, 1927, pp. 345, 405, 452.

and accounted for, labor standardization, by tests and otherwise, decreases rapidly in validity. Accurate analysis of the individual's potential capacity and actual skill becomes impossible.

Formulating labor standards is but one phase of the whole process of knowing how well the factory and office, or company, is being run. Labor standards must be integrated with all the other operating standards of the business. We have shown how closely the processes of selection and placement articulate with other operating standards and to what extent they are dependent upon the various physical standards. Furthermore, unless the control of all operations run smoothly, no standard can long retain its value.

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CHAPTER XVII

PRACTICAL ASPECTS OF THE DEVELOPMENT AND USE OF STANDARDS[1]

THE foregoing chapters have described many kinds of standards and have told how to devise them. This chapter will deal with some practical problems that arise in the process of adapting those ideas to a particular business organization. This discussion can be only sketchy, for a detailed treatment of the sequence in which the several ideas should be applied and of the processes of application would require volumes instead of a single chapter. The treatment will proceed largely from the viewpoint of a manufacturing business.

The executive should guard equally against two assumptions: that the whole process of devising and installing a mechanism for applying scientific principles to the management of his business can be completed satisfactorily in a few weeks or even a few months; and that the whole process must be completed before benefits in the way of economies will begin to accrue.

With most manufacturing organizations, the major portion of the mechanism can be devised and put into operation by the expiration of two or three years. It has been the experience, however, that some improvement work is likely to be in progress as late as ten years after the process was commenced. Indeed there are cases in which portions of the mechanism that was installed originally have given place to mechanism that was even more improved.

Standards May Give Place to Improved Standards. The last statement introduces another important truth. Progress in the application of management principles does not stop with the completion of the installation of a mechanism (if installation may even be said ever to be completed). Improvement in mechanism is progressive. The standards determined and applied originally were the "best," it is true, but only in one or two restricted senses: they were the best that scientific research had discovered up to the moment of their adoption; or they were only the best that were available to the particular enterprise at the time because of the limited volume of its business, of the equipment that it already possessed, or because of the limited capital at its command at the time. As the volume of business of the enterprise

[1] By Thomas W. Mitchell, Associate Economist, Federal Trade Commission, Washington. The discussion in this chapter anticipates some of the information to be found in later chapters.

grows and its command of new capital increases, there become available methods, appliances, organization and other factors that were unavailable before. Furthermore, the progress of general science and of specific research result in discovery and invention of processes, appliances, methods and mechanisms that are improvements upon the best that were known previously. When scientific research discovers something better than an existing standard, the new in turn becomes the "best" and the "standard," and the old is discarded. Science in management does not lead to stagnation.

A Program of Development. Not all parts of the process of applying science to management need be carried on at the same time. Indeed, it is much better to divide the whole process into sections and to plan a program of installation. Certain features can be started at once with profit and others deferred until a more suitable time. Certain features cannot be installed advantageously or successfully until certain other features, requisite for their successful application, have been installed. For instance, performance standards, which many manufacturing executives wish to apply in the first week, cannot properly be applied until after scheduled maintenance of equipment and tools, standardization of materials and suitable preplanning and preparation of work have become standard practices.

Cumulative Savings. The establishment of such standard practices, however, yields savings of its own. Properly scheduled inspection and adjustment and repair of motors, machines and belts save much wage cost and loss of output from breakdowns. Proper care of tools avoids much loss of output. Study of the machine processes with a view to determining best speed and feed combinations for the various varieties of work, and application of the laws discovered, in themselves increase the rate of output of the operatives. Installation of the mechanism and routine of planning a manufacturing order and of the order-of-work mechanism described in Chapter XXII avoids much waste of wages and loss of output by always providing work ahead of each operative and by assuring the presence of all needed materials, appliances, instructions and guides at the moment that a specific "job" or assignment of work is given him. Even the construction of classifications and the thorough-going substitution of the classification symbols in the written and spoken language within the organization secures important economies; for it is much less expensive to type on a stores order "18'SV4SIR" than to type its equivalent, "18 feet of round cold rolled steel 4 inches in diameter."

Direction of Research and Standardization. There should be one person in the organization whose sole function is to direct and coordinate research and the formulation and application of the improved

mechanism. This important function cannot advantageously be assigned to one who has other responsible duties to perform constantly, for two reasons: the work is such as to require the whole attention and best thought of one who by reason of previous study and experience has full faith in the value of what he is doing; and a functionary who regularly has other important duties usually does not have the requisite background of study and special experience, and will neglect this work.

If this director is not to be guided by the advice of a consultant in management, he should be an individual who has spent years in the study of management principles, in assisting elsewhere in the installation of mechanisms or in their application; and he should have had the chief directive responsibility under a consultant in at least one other installation. If he is to be guided by a consultant, the present installation may be the first in which he has had the chief directive responsibility; but he should have had much experience in assisting in previous installations in responsible capacities. It is important in either event that he have a grasp of principles, which are the spirit, as well as a wide acquaintance with mechanisms, which are the vehicles through which the principles work, so as not to be a slavish copier of particular forms of mechanism in conditions to which they are not adapted. Finding such a director is an important duty of the consultant.

Procedure of Development. 1. *Management Survey.* The first step taken by the director should be a systematic management survey, guided by the latest improvement of the survey questionnaire devised by the American Engineering Council's Committee on Elimination of Waste in Industry.[1] The method of conducting the survey should be such as to afford the director a large amount of personal inspection of planning mechanism, administrative mechanism, records and organization, and also considerable acquaintance with the products and the processes involved in their fabrication. An intensive study of the data so compiled will reveal the chief weakness of the existing management and will greatly assist the formulation of the program.

This program naturally will be formulated by the director of the installation, or by him and the consultant. The original program will not be complete; it probably will deal with the first few major features to be started, leaving the extension of the program to be formulated in the light of current experience. Whether it will be submitted in its entirety for executive approval, or whether the first recommendation will deal only with the particular feature to be started immediately, will depend upon circumstances; step-by-step submission is preferable if practicable. However, definite embarkation upon any major feature will naturally be preceded by authoritative approval.

[1] *Waste in Industry,* New York, McGraw-Hill Book Company, 1921.

2. *Certain Features Should Be Started Early.* The management survey may show important weaknesses that should receive special attention before a general program is embarked upon. Successful treatment of these will breed confidence in the value of later work. Other than such special situations, however, the general program should provide for the starting of certain features early. This should be done partly because the features are valuable for their own direct effects, partly because they are necessary antecedents to other features.

3. *Classification and Symbols First.* The advantages and method of constructing classifications and symbols were set forth in Chapter IX. Probably this mechanism should be started first. The start would be made by selecting an individual who later will become chief of the function of maintaining and amplifying the classifications and the use of the symbols. The master classification and several if not all of the major classifications—functional, worked materials, stores, machine and work place, etc.—will be made by the director and this functionary in association. It may also be advisable in connection with each major classification, to call into participation the individual who later will be most continuously concerned with its administration; *e.g.,* the chief of the tool department in a metal cutting establishment. In a manufacturing organization, the future chief of the classification and symbol function should be one who is qualified by education and by technical knowledge of the products and processes to become also the future chief of the routing function, for two reasons: knowledge of the manner in which the parts of an assembled product come together in the production process is necessary for proper construction of a worked-materials and of a stores classification, and eventually the duties of the classification function will probably become so light as to lead to consolidation with some other function.

4. *Tickler and Messenger Service.* A feature that probably will not appeal at first to the executive as important is the standard "tickler" with a unified and scheduled messenger service. A tickler is a file in which memoranda are filed according to the dates at which they are to come to attention. It should be placed in charge of a chief messenger, and one or more messengers should make rounds at stated intervals both to distribute mail and other communications to the various functionaries and subfunctionaries and to collect mail and communications from them. Memoranda of matters for future attention should be gathered, brought to and filed in the tickler. Each morning the chief messenger should take from the tickler all memoranda filed under that date and send them to the functionaries addressed.

The equipment needed is a cabinet with drawers and filing folders of sufficient capacity and number to take care of memoranda to be

filed ahead two years; a standard form for such memoranda, which can also be used for current interfunctionary communications; and probably a standard envelope in which to enclose such memoranda when entrusting them to the messenger service. There should also be a typewritten routine describing in detail the duties and procedure of the chief messenger and of each messenger.

The messenger service should take care of all interfunctionary written communications except communications from the order-of-work clerks to the operating executives in the factory. These require immediate transmission, and cannot wait on the hourly schedule of a general messenger service.

In establishing such a general messenger service, difficulty is likely to be met in overcoming the established habits of the various managers, especially of the chief managers. The latter are likely to try to appropriate the regular messenger, when he appears, and send him on special errands, even to buying cigars for them. This should be prevented. If there is a considerable amount of such errand work to run, one or more other messengers may be provided to run such errands on call. However, a large amount of special errand service is not a sign of good planning.

5. *Written Routines—Standard Practice Instructions.* Reference has been made to a written routine containing detailed instructions of the duties and procedure of the chief messenger and of each messenger. Such written standard practice instructions should be prepared for each function as it is established. They define the function and serve as a guide to any new incumbent in case of the sudden removal of the experienced functionary.

6. *Machine, Motor and Belt Maintenance.*[1] Three of the classifications referred to above will, in the case of a manufacturing organization, be those of work places, motors and belts. After they have been completed and the symbols have been attached to the machines and other work places and to the motors, certain other mechanism necessary for systematically scheduling the inspection of these devices for maintenance can be put into operation.

A portion of this mechanism consists of an individual belt record, an individual machine record and an individual motor record, and, of course, a keeper of these records. In a small establishment, this record-keeping and maintenance-scheduling function may be combined with some other function (*e.g.*, a time study clerk function) in order to utilize fully the functionary's time; in a large establishment this one function may occupy all of the time of one or several individuals.

Inspection and repair of machines and motors are activities that

[1] Cf. Chapter XXIII.

by their nature require the services of qualified mechanics and electricians supervised by mechanical and electrical engineers. These may properly be grouped in a maintenance department, which may also have charge of janitorial work.

7. *Expert Service on Machine Speeds and Feeds.* Other fields in which the service of specialists is likely to be needed in a metal-working organization are: the treatment of metal-cutting tools in order that they may withstand high speeds; the classification of the metals with reference to hardness; the determination of the best cutting speeds and feeds for the respective classes; and the ability of the respective lathes, boring mills, etc., to develop the necessary power and withstand the strains incident to these speeds and feeds. Probably the expert in these matters will also possess expert knowledge on belt tensions. If so, the study of all can be started at about the same time. In any event, some of the most profitable features of the installation in a metal-working establishment will consist of the tool treatment, the classification of the materials with reference to hardness, and the mechanism for determining the best combination of speed and feed in each particular case. Such knowledge should be ready for application before any attempt is made to determine and apply performance standards.

8. *Application of Symbols to Store Room and Materials Records.* As soon as the classification of worked materials and stores has been completed,[1] the symbols should be applied in the stores department and in the materials ledgers. If the store room has been operated systematically, each variety of materials, supplies and stock parts will bear a tag showing the name, description and probably the quantity on hand. Each such description should be identified with the corresponding description in the worked-materials or stores classification, and the class symbol should be entered on the tag (which will be assigned and will bear a stores symbol). Then the physical positions of the several varieties of stores and worked materials should be rearranged as to place them in an alphabetical-numerical sequence of the letters and numbers in the symbols according to some scheme of progression that is adopted as standard. As this is done, it probably will be advisable to check the quantities shown on the tags by making an actual count of the materials.

In similar fashion, the names and descriptions on the materials-ledger sheets should also be identified with the descriptions in the classifications and the symbols should be entered in the upper right corners

[1] "Completed" in the sense of including all product and product parts being made, and materials and supplies being used at the time. New designs of product and the introduction of additional varieties of materials will cause extensions of the classifications.

of the respective sheets. Then these sheets should be rearranged in alphabetical-numerical sequence.

9. *Standard Balance-of-Materials Sheets.* The foregoing step leaves the materials ledger bookkeeper an old-fashioned materials ledger bookkeeper still. However, the next step in the process of transforming him into a balance-of-materials clerk can be started at this point, by planning the form of the balance-of-materials sheets and ordering a supply. The body of one of these sheets has four main divisions, for the following purposes: the quantity of the particular variety of materials (stores or worked) ordered but not yet received in stores; the quantity and cost of the materials in the store room; the quantity allotted or "apportioned" to manufacturing and sales orders (designating each by symbol) but not yet issued from the store room and the unallotted or "available" balance. The sum of the quantities in the first two divisions always equals the sum of the quantities in the last two. The "available" balance is available, not necessarily in the sense of being on hand physically, but in the sense of being either on hand or ordered and not yet apportioned to specific orders.

A very important feature of this system of record keeping consists of the combination of an assigned minimum balance and standard requisition. This is expressed by the printed formula in the heading "When available balance falls to ——, issue requisition for ——." For each variety of stores and worked materials, a definite quantity will be determined and inserted in each blank space. The magnitudes of these quantities will be determined by consideration of the rapidity with which the article is used, the length of time required to replenish the supply, and the size of lot that is most economical from the viewpoint of manufacturing or of purchasing and transporting inward. The aim will be to adjust these two quantities so as to keep the investment in the material on hand at the minimum amount that is consistent with always having it physically available in the quantity needed when needed. This and the "apportionment" feature are valuable features of the materials records, and are the features that, when put into operation, will convert the keeper of this record from a mere recorder of past occurrences into a planning functionary.

10. *Route Charting.* With the completion of the worked-materials and stores classifications, this functionary can be started upon the important work of constructing a route chart for each design of finished product. The analytical charts made in the process of classifying the worked materials will help greatly in route charting. The designs of product made most frequently and in largest quantities should be charted first. In the construction of each such chart, each part, each stores item and each worked-material item to be used, and each work

place at which an operation is to be performed, will be represented by its classification symbol. Also each operation will be assigned a symbol, which will be effected by prefixing a number to the symbol of the part being made at the particular juncture.

11. *Planning Routine.*[1] It is quite likely that the business organization will have developed a process of planning manufacturing orders. The established process will need some modification so as to incorporate improved features. These include a standard process of originating a manufacturing order, standardized sizes of manufacturing lots and a standardized routine after the order has been originated. The routine may be sketched as follows:

a. The routing functionary will check the bill of materials and route chart against the design drawings furnished by the designing or engineering department. Finding these correct, or correcting them, he will cause route sheets and orders on the store room to be typed from and checked with the route charts. These documents constitute part of the contents of a route file.

b. If there are special stores, such as castings, to be purchased, the partially complete route file goes to a functionary who requisitions the purchase of these articles and makes all necessary special preparations such as getting out patterns for delivery to the foundries.

c. The file then goes to the balance-of-materials functionary, who "apportions" the stores and stock of worked materials called for. He also requisitions the purchase or manufacture of a standard lot of any of these materials whose "available balance" falls to or below the "minimum balance limit."

d. The file goes to a route file clerk, who provides for each operation a time card, inspection ticket, one or more "move" tickets, a set of "operation order" tickets for visualizing the operation on the order-of-work boards and a worked-materials-received-in-stores ticket for the last operation on the manufacturing order. He also provides an identification tag for each lot of stores and stock of worked materials that is to be issued from the store room. He also provides a pocket sheet for each route sheet, puts each bit of control stationery in a standardized place, and makes up the whole into a bound route file.

e. If a time-study and instruction-card-file function has been established, the route file then goes to it for provision of instruction cards and tool lists and, after the determination of performance standards, for designation of the standard time for each particular operation on its time-card and operation-order tickets.

f. The route file will then be placed in a rack pending the arrival

[1] Cf. Chapter XXII.

of the special stores and of any other materials that were apportioned but not on hand and available.

g. There will also be a standard process of making note in these route files when materials become available and of getting out the operation-order tickets and placing them on the order-of-work boards so as to start work in the factory.

There should be prepared a typewritten routine or standard-practice instruction for each planning function. This should describe and illustrate in detail the procedure to be followed in each class of case that may come before the functionary.

12. *Cost-Accounting System.*[1] With the establishment of the standard planning routine as sketched above, the opportune connection is created for introducing a cost-accounting system or for modifying the existing cost system so as to adapt it to the management mechanism. This is particularly so if the factor-rate method of applying indirect costs is to be used. For each time card can be made to show, especially when the "job" is completed, the symbol of the work place at which the "job" was performed. Each time card can be "priced" so as to show the indirect expense assigned through the particular work place as well as the direct labor cost. The "priced" stores- and worked-materials tickets, together with credit tickets for any such materials that were issued but returned to the store room, furnish the data concerning direct materials costs.

It will be advantageous to introduce or adapt the cost-accounting system at this juncture because it can be used to compile costs in such manner as to show the effects of the installation of the later features upon cost reduction. For this purpose it may be advisable for a while to compile direct labor and indirect costs by operations. This detail can be discontinued when the comparisons are no longer desired.

13. *Order-of-Work Boards.* Mention was made of order-of-work boards. Detailed description of this mechanism, its purpose and its method of functioning is given in Chapter XXII. It is mentioned here only because the preparatory planning process provides the stationery that is used on the boards as well as the time cards, inspection tickets, move tickets, instruction cards, tool lists, drawings and sketches that will be issued to the factory in response to orders or signals given by the functionary who operates these boards.

Before formulation of the planning routine can be completed, decision has to be made as to the particular form that the order-of-work mechanism is to take, also upon the question whether the order-of-work boards are to be concentrated in a planning department or distributed throughout the factory. In the case of a large manufacturing plant

[1] Cf. Chapter XXVI.

such as that of the Winchester Repeating Arms Co., which in 1919 covered forty acres of ground and carried on in separate buildings such dissimilar work as making rifle shells, shotgun shells, bullets, rifles and shotguns, and fishing tackle, it is probable that the minimum of distribution would provide a separate order-of-work board for each important class of product. Certain manufacturers have found it advantageous to provide a separate order-of-work board for each group of operations that are also grouped in space, and to place each board in the immediate vicinity of the group to which it pertained. On the other hand, most small manufacturing establishments will find it advantageous to concentrate the order-of-work boards in the planning department, perhaps using pneumatic tubes to transmit orders between the order-of-work functionary and the operating force.

The decisions having been made, steps should be taken to provide the boards, and to select and train posting clerks. Also steps should be taken to select an order-of-work chief or constitute an order-of-work committee. The function of such a chief is to determine at standard intervals and to express in typewritten orders the sequence in which preference should be given to manufacturing and maintenance orders in process in the factory, also to manufacturing, maintenance and sales orders in the process of planning. A representative of the sales division should participate in this function, as delivery promises have a large bearing upon the sequences. This functionary is customarily called the production clerk, and is the chief of the planning department. The chief of the maintenance department will be an interested party to the extent that maintenance orders compete with manufacturing orders in the factory.

14. *Transportation System in the Factory.* Mention has been made of "move tickets." This refers to the fact that material must be moved from store room to factory work place, from work place to work place, and so on, and the movement must be controlled. Sometimes the work-place-to-work-place transportation is performed by the operatives themselves by obtaining their work at specified work-ahead positions and delivering their finished work at other positions which are the work-ahead positions of the succeeding operations. Sometimes it is done by inspectors. Often, however, a special personnel and special equipment are necessary. In the last event, a move order would be provided for each operation.

The nature of the transportation system and equipment will depend in part upon the character of the product and the arrangement of the factory. Some products and arrangements are adaptable to the use of mechanical conveyors. In such cases the speed of a conveyor may be important. After performance standards have been determined and

applied it may be possible to work out a plan whereby some kind of mechanical conveyor can be substituted for other means of transportation, so as to feed the product past successive groups of operatives. Such groups will be so proportioned to each other that each group can perform its operation on the same number of units per hour as each other group.

Decision as to how the shop transportation is to be performed must be made so that, if necessary, proper provision for transportation can be incorporated in the planning process as well as in the administration of the order of work; also so that if personnel will be needed, it can be provided and trained.

15. *Determination of Performance Standards.* The procedures already discussed constitute steps that lead to the establishment of performance standards. Indeed, in a particular establishment or industry, it may be necessary because of the attitude of the personnel to defer any direct research looking to the determination and application of performance standards until all other mechanism has been installed. Carl G. Barth once stated that he carried installation work on in the shops of the Pullman Company during four years without making a time study, and yet important economies had been effected.

A performance standard implies an operation with a standardized work content upon a standardized material, with standardized appliances by a standardized method under standardized conditions. This implies much in the way of research and standardization of other things before entering definitely upon those analytical timing observations that result directly in the performance standards.

Time-study research, however, will assist greatly in the discovery of undesirable conditions, appliances and methods; *i.e.,* in the determination of the other standards. This would be an important use of the time-study research function even if it were not to determine performance standards eventually. Consequently it is well to start preparations for such a function as soon as a standard planning routine has achieved smooth working.

The start consists of the selection of an observer and the commencement of his instruction in methods of time-study observation. If the director of installation is himself an experienced time-study observer, he can attend to the selection and training. Or this may be done by the consultant. In some cases it may be advisable to engage one experienced time-study observer, either temporarily or permanently, from some other organization. Other than the first selection, however, time-study talent should be developed on the ground rather than be imported.

Distinction should be made between the time-study research function and the time-study clerical function. The research function makes

actual time studies—over-all or elementary. Its over-all studies assist materially in the process of standardizing conditions, appliances, methods, even work contents. The elementary time studies furnish data on the time necessary for the elementary components of operations; and these data may be classified and filed for later application to the specific elements of specific operations. The research functionary also analyzes operations into their component elements and prepares a detailed instruction card for each operation. The time for each element may be applied from filed data by the clerical functionary.

The clerical functionary receives, classifies and files data received from the research functionary, and applies them to the elements on instruction cards prepared by the latter. He may also make up, for convenience in reference, tables showing the standard times for lots of various sizes. He provides and files blue-print copies of the instruction cards and furnishes copies to the route files of specific manufacturing orders. He also enters the standard time on the time card for each operation, and on the operation order tickets that go on to the order-of-work board—planning and shop.

The time-study clerk is a routine-planning functionary; the time-study observer is a research functionary. It is important to qualify a time-study observer properly both technically and so as to command the respect of the operatives.

The individuals selected for training may well be young graduates of technical high schools or other technical schools. They should acquire considerable knowledge of the processes involved in making the product before their instruction in making time-study operations commences. One manufacturer, whose plants consist largely of metal-cutting machine shops, gives each candidate for the degree of time-study observer a three months' experience as a machine-shop operator, and requires him to develop at least as much speed as the average operative. Such experience not only better qualifies him as an analyst, but better enables him to command the confidence of the operatives.

16. *Mechanism That Should Precede Application of Performance Standards.* A performance standard, once determined, should be put into effect as soon as is practicable—not even waiting for the determination of other performance standards. Certain conditions are prerequisite, however, to the assignment of any work on task and bonus, differential piece rate or any form of incentive wage.

First, it is necessary to have a planning and order-of-work mechanism that will so operate as not to give out any particular "job" until it is known that the requisite materials, tools and instructions are at the work place. Such mechanism was referred to above.

Second, there should be provided a corps of factory executives, each

with a definite group of work places assigned to him, one of whose most important functions is that of checking up in advance on each "job" that is posted for each work place to ascertain that the requisite materials, tools and instructions are actually at the work place. Such functionaries are commonly called "gang bosses," although "preparation boss" better describes the function.

Third, there should be provided a corps of instructors in the methods of performing the work, each with a definite group of work places assigned to him. Each instructor, while exercising general supervision over the methods used by all operatives assigned to him, will devote most of his efforts to teaching new operatives who have not yet reached standard. Taylor made the "gang bosses" in metal-cutting factories instructors in the setting up or handwork portions of the machine operations. He provided a separate corps of instructors for the machining portion of the operations, calling them "speed bosses" because they had jurisdiction over the feed and speed adjustments of the machines. The name had unfortunate consequences because uninformed persons pictured these instructors as speeding up the worker rather than the machine. A certain manufacturer avoided this psychological difficulty by calling these instructors "adjusters." In non-metal-cutting factories there is usually but one corps of instructors, and they may be called by that title. One manufacturer diplomatically calls them "functionnaires."

Fourth, there should be a standard system of providing for inspecting and repairing tools so as to insure the presence at the work place when needed of the right tools in standard operating condition. In many establishments in which tools are few and do not change from "job" to "job," they may be kept permanently at the work places. Even these, however, require inspection and repair at standard intervals. Repair schedules coming out of the tickler at these standard intervals will remind the tool-maintenance functionary of this duty. In metal-working establishments, however, it will usually be found advisable to maintain a tool department (or several of them in a factory that covers a large area) for the purpose of systematically inspecting and repairing, storing and issuing tools. Such tools will be issued in response to tool lists checked by the gang bosses and in exchange for tool checks; and tools, tool lists and tool checks will be transmitted by tool boys.

Finally, there must be standard quality specifications and a corps of inspectors to reject work that does not comply with the quality standards and to instruct the operatives and instructors in the method of performing the work so as to comply with the quality standards. A common fear among designers is that quality may be sacrificed in the

endeavor to increase production quantitatively. It should be understood from the beginning that product that does not comply with the quality standards is not product—it is only near-product, or junk or stuff for jobbers.

Usually there is a certain amount of inspection already. Often it occurs only after a series of operations. An important question in the particular factory is whether inspection after each operation is necessary where performance standards are in effect, or whether the operations can be so grouped that inspection after the last operation in each group will suffice. In a certain clothing factory, the latter was done, each operative being held responsible not only for his own defective workmanship but also for each item of defective workmanship of predecessors passed by him. The danger of group inspection is twofold: that responsibility for defective workmanship cannot be placed; and that useless work will be done and expense incurred on product that has already been spoiled. Generally, inspection after each operation is preferable. The question must be settled and the inspection system must be put into operation before attempt is made to put performance standards into effect.

17. *Compensation of Instructors and Inspectors.* The compensation of instructors is frequently made to depend in part upon the progress of the operatives assigned to them. After a little experience under the intensive instruction system a standard schedule of progress of the new operatives can be determined—such as doing work in double the standard time during the second week, time-and-one-half during the third week, time-and-one-quarter during the fourth week, and standard time during the fifth week and thereafter. By such a device it is practicable to offer an instructor a bonus that progresses with the average weekly performance of the operatives assigned to him.

Gang bosses can be similarly compensated. The remuneration of inspectors, however, should not depend upon the efficiency of the operatives, for obvious reasons.

18. *Performance Standards Determined and Applied in Sequence.* Attempt should not be made to determine performance standards for, and apply them to, the work of all departments simultaneously. The best procedure is to select one kind of operation and devote all attention to it until the study is well under way. For instance, in a handkerchief factory, the folding and ribboning operations were studied and put on task and bonus. Later two experienced observers were started in the hemstitch department, each taking a different variety of hemstitch work; while a third worked under close supervision in the handkerchief box department.

In a metal-working establishment, an observer might be started

on drill-press operations. He would study the time required to make the various adjustments of each drill press, such as changing speeds, starting the press at the beginning of a job and stopping it at the end, starting and stopping by throwing a shifter, raising or lowering the head per inch, moving head on rail, swinging arm to position over work, swinging arm away, etc. He would also study the time required for putting various clamping and adjusting devices on to the drill-press table or into its slots; the time required to put an assembled drill and sleeve into the spindle and to take them out; the time required to assemble drills in sleeves and to dissemble; and so on. He would study the time required to drill to lip, to raise a drill out of the hole, to clean shavings out of a drilled hole, and so on.

Similar remarks apply to the study of a milling machine, of an engine lathe and of other machine work. Some of the results would be tabulated under the heading of the particular machine, some under the heading of the particular tool. Much work with tools that is not machine work can be tabulated in the latter manner.

An important class of elements in the operations in a metal-working plant consists of those elements of work done by the machines rather than by the operative, such as the travel of the drill, the lathe or boring tool under the mechanical power drive. In these the number of revolutions of the drill per minute, or the linear speed of the material under the lathe or boring tool, together with the coarseness of feed (and, in lathe and boring-mill work, the depth of the cut), are all important factors in determining the time of the element. These in turn depend upon the hardness of the material, the ability of the tool and machine to withstand strain and heat, and the power of the machine. These matters are not determinable by ordinary time study but by scientific engineering knowledge. The best procedure is to requisition the services of a specialist in these matters to classify the materials, study the power and speeds of each machine and the durability of the tools, and to prepare slide rules that the time-study functionary can use in analyzing each particular case that arises.

19. *Performance Standards Applied to Operatives in Sequence.* Furthermore, attempt should not be made to apply performance standards to all operatives on even the same operation simultaneously. The writer, in putting a certain group of handkerchief hemstitch operatives on task and bonus, put the best operative on task and bonus first. He devoted a whole week to protecting this operative's record against the effect of unstandard conditions, such as belt breaks, slowing up of drive shafts and inferior thread. With proper adjustment of time for such of these events as occurred, the operative delivered all "jobs" in standard time, thereby demonstrating to herself and all others that standard

could be attained. Then two other operatives were started on task and bonus and similarly protected for a half week, then four other operatives, and so on until all were on task and bonus. Each started at the beginning of a new "job." The most skillful operatives attained standard at once. In several cases it was necessary to teach the less skilled operative the method of handling a handkerchief used by the best operative. The whole group, with exception of two women of advanced age, progressed rapidly toward standard and the whole operation was deemed a pronounced success. It is advantageous thus to "nurse" a group until standard conditions become the normal feature and until the operatives are convinced of the fairness of the standards and of the management.

It is highly important that the process of putting operatives on task or bonus, or on any other form of incentive wage, should be carried on in such careful manner as to convince them that the management actually desires that they earn the larger wages offered and wishes to be just and fair in all matters. The writer was handicapped in his endeavor to get a certain group of youths on to task and bonus by the feeling among them that even if they earned the offered bonus, the company would find a way of cheating them out of it. After several weeks of hard work he got them to earning the bonuses. On the next pay day no bonus money was in their pay envelopes. Fortunately the writer had given each operative a memorandum of each bonus earned and had kept a copy. He took these to the payroll department, proved each item, and insisted that the paymaster make a special trip to pay these boys. The promptness with which the payroll department's lapse was rectified dissipated the former feeling. Unintentional mistakes may be disastrous. The management must be willing to spend five dollars, if necessary, to correct an error of ten cents.

20. *Balance of Work and Balancing the Shop.* As soon as performance standards have been determined and put into effect for all or practically all work in the factory, it becomes possible to compile a "balance of work," which will express in standard hours of work the amount of work waiting to be done at each work place or group of work places, and the amount of work already planned that will come to each group in the future.

In at least one manufacturing establishment such information is used as a guide to "balancing the shop," *i.e.,* reapportioning the labor force among the various kinds of operations daily so as to pass practically the same number of units of product through each operation.

By finding the quotient of the total number of standard hours of work ahead of the factory divided by the number of direct workers it is also possible to express the amount of work ahead as a number

of factory hours. Such information is of value for the purpose of stimulating the sales division and of planning future additions to or reduction in operating force.

21. *Other Branches of the Business.* The discussion up to this point has been confined to the problems and processes of installation in the production division. This will usually be the easiest point of attack, although more benefits may come eventually from application of the same principles to the sales division and to the office work. Furthermore, results after the production division has been so reorganized are likely to assist greatly in pointing out the policies and methods that most merit study in the other divisions.

A prominent feature of many manufacturing businesses is the fluctuation in the volume of business written by the sales division and the consequent fluctuation in the volume of work that goes through the production division and in the number of production operatives needed, if the custom has been to accommodate the one volume to the other. After performance standards have been put into effect in the production division, the loss in operating efficiency, and the increased unit cost caused thereby, because of substandard employees during a period of rebuilding the force after a seasonal lay-off, will attract attention forcibly—because it will be measured. This will raise questions of manufacturing policy—such as producing for stock or producing other commodities whose seasons dovetail, so as to even the flow of production in time. Persistence of cyclical fluctuations in the inflow of sales orders will more forcibly raise questions concerning sales methods, sales policies, sales organization and sales management, the subject matter of Chapters XII and XIII.

22. *Departmental Budgets.* Certain management engineers would no doubt have introduced ere this the budget system for the purpose of establishing departmental expense standards. The expenses of the sales division or of any planning or administrative office should have some reference to the volume of business transacted. A unit of reference commonly used is the dollar of sales. In the absence of anything better, this affords a rough base—but very rough for two reasons; it is not a stable base, because it swells and shrinks with changes in the prices at which the products are sold; and the total expenses do not vary in direct proportion to the total volume of sales, even if the prices were not varied.

In order to obviate the latter difficulty, John H. Williams has evolved a plan of classifying expenses as fixed and variable, the latter varying directly in proportion to volume of transactions, the former changing only after a large change in volume. And he evolved a formula whereby not one standard, but several sets of standards according to

possible variations in prospective volume of business, could be set up in the budget-making process.[1]

Williams probably would commence his work of installation by such a process of budget making. After performance standards have been put into effect for all or practically all work in the production division, both the sales quotas and the sales orders can be expressed in terms of standard man hours and standard factory hours. Expression of sales expenses and of the various planning and administrative office expenses as expenses per production man hour will afford another form of unit cost that may be a truer index than expression in terms of a dollar of sales, of economy of operation (or lack of it) in those functions. Of course there will still be the variability in unit cost according to the volume of business.

23. *Personnel Administration.* Discussion of this topic at this point does not imply advice to defer the establishment of a personnel division until everything else has been attended to. However, the determination, application and maintenance of standards of operating conditions, of planning and service, of appliances, of methods and of performance will greatly reduce the difficulty of determining the personal requirements that fit an individual for a particular kind of work.

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Cf. Chapters XXVII and XXVIII.

[1] Cf. Chapter XIX.

PART IV

CONTROL

1. The Control of Operations

Do you know what amazes me more than anything else? The impotence of force to organize anything. There are only two powers in the world: the spirit and the sword. In the long run the sword will always be conquered by the spirit.—NAPOLEON.

Genuine power can only be grown, it will slip from every arbitrary hand that grasps it; for genuine power is not coercive control, but coactive control. Coercive power is the curse of the universe; coactive power, the enrichment and advancement of every human soul.—MARY P. FOLLETT.

In concluding let me say that we are now but on the threshold of the coming era of true cooperation. The time is fast going by for the great personal or individual achievement of any one man standing alone and without the help of those around him. And the time is coming when all great things will be done by the cooperation of many men in which each man performs that function for which he is best suited, each man preserves his own individuality and is supreme in his particular function, and each man at the same time loses none of his originality and proper personal initiative, and yet is controlled by and must work harmoniously with many other men.—FREDERICK W. TAYLOR.

Cooperation means, I take it, uniting the manifold streams of human will-power or conscious energy into a single stream directed upon a common object. . . . To attain cooperation is by no means to give the human will a holiday. It furnishes the will with a new task and challenges the activity of it on higher and more difficult ground, that, namely, of sustaining and continually vitalizing the organized life that has been called into existence—the service, one might say, of the cooperative principle itself. It implies the continuous self-mastery of the cooperating individuals . . . the highest conceivable state of moral energy. And this energy would not be supplied . . . from some external source. . . . It would have to be generated by the continual self-affirmation of the wills of the cooperating members and could have no other source.—L. P. JACKS.

CHAPTER XVIII

CONTROL IN CONTINUOUS, INTERMITTENT AND VARIABLE PROCESSING[1]

UNDER any type of manufacture some control of the productive process is essential to smooth flow of processing and to meet sales demands. Differences in the means of control must vary with the type of manufacture, though fundamental principles of control remain the same. Since control of production is necessary not only to utilize fully the facilities of a factory, but to see that the demands of customers are met, under no conditions can control of production be considered without control of sales and the correlation of the two.

Controlled correlation of sales and production[2] takes into account the following factors: (1) prospective sales over a season, or a period of months, by product; (2) prospective sales by the week, or similar production period; (3) possible hourly production by each unit of the plant, subdivided into classes of work that can be done in the normal working schedule; (4) possibilities in overtime production; (5) technical production possibilities of the equipment, including the effect of pushing certain lines of product that are made on special equipment, or which use multiple-purpose equipment; (6) costs of idleness, subdivided to show the idleness charge for each machine or class of equipment; (7) effect on the business of selling constantly the full capacity of the plant; (8) extent of obsolescence and depreciation of machinery and equipment; (9) style changes; (10) possibilities of meeting customers' wishes in product and in delivery date; (11) the cost of securing sales; (12) the tangible and intangible results of cyclical employment and days without work, or "unemployment within employment"; (13) the financial aspects of manufacturing to stock, or ahead of sales demands; and (14) competitive conditions within the industry, particularly as regards quality, price and service.

It will be seen immediately that, since these factors are so diverse, there can be no one way of establishing control over the productive process in industries whose manufacturing problems and methods are also diverse. In some cases, particularly in standard, quantity manufacture, the steps in controlling these aspects of the business can be taken before production is begun on any one model or line of product.

[1] By Richard H. Lansburgh, Professor of Industry, Wharton School of Finance and Commerce, University of Pennsylvania, Philadelphia.

[2] Cf. Chapter XII.

In variable or diverse manufacture, the more important steps of control come after a specific order is received, and depend in their execution upon the status of other orders in manufacture.

In standard, quantity manufacture, each unit of product is similar to every other unit of a particular line and there are several lines in production at any one time. It is therefore the effective layout of machinery and equipment which permits of smooth and uninterrupted processing. Actual day-to-day planning is simplified, and daily or hourly follow-up of the preplanned schedule controls the productive process as desired by the executives in charge. Many lines of industry are striving for the beneficial results of a standard, quantity-production basis. Not the least of these results is the ease of control, but another is specialization in manufacturing method. With an increase in sales it becomes profitable to introduce specialized equipment, including many labor-saving devices. These in turn further decrease the costs of production, thereby possibly further increasing sales and making control still easier. In this type of manufacture production is scheduled against the sales schedule, smoothing out the sales curve over a period of months to secure constant production. The sales schedule comes from a careful analysis of territories, with sales quotas set on the basis of competition, population, buying power and need for the product within that territory. If current business conditions remain fairly constant, and if the quotas have been set with care, the production schedule may remain as set forth months ahead.

In making the schedule that will control standard, quantity production, the needed output over a period of time must be balanced against the capacity of equipment available. Since it is known for just what each piece of equipment will be used, this can be done months ahead. If the projected schedule is greater than the capacity of the equipment, the management must decide whether additional capital is to be invested in equipment, whether there is to be overtime in some departments, or whether any of the production can be let out to other manufacturers. In assembly industries there is much opportunity to even out production schedules by letting work out, but this cannot be done with ease in continuous industries such as sugar or flour manufacture, or even in the production of textile fabrics. In any case, a time-distribution schedule, which shows the exact time before the final operation that each previous operation must be performed, becomes the basis of all control in this type of industry.

Control problems vary in intermittent and variable industries as well as in standard ones according to whether the product be assembled or whether it be produced continuously from one lot of raw material. If an assembled product, some components may take much longer to

manufacture than others, or the problems of manufacture of the several components may be essentially the same. The machinery and equipment that is utilized frequently depend on whether or not the product is standard. In standard production, even of an assembly product, the machinery and equipment can be set up so that the planning control problems are essentially those of a continuous industry. Thus through the use of conveyors, machined pieces may be made to flow into assembly points in much the same manner that sugar flows from one operation to another in manufacture. The daily control problems are essentially the same in either case—provision of sufficient raw material to perform the first operation, and check of hourly production to see that daily and weekly production schedules are being met. Similarly, it matters not whether the production be continuous or assembly, if each machine perform but one operation and be suited to perform only that one operation. In either case all work must pass through that machine, and the layout in relation to the machine before and the machine after must be accurate. There is no problem in deciding when work shall be done on such equipment, because that is established in the layout.

If production be intermittent or variable in character, single-purpose machinery cannot form the basis of shop equipment. Although some single-purpose equipment can be used for particular operations on products that form the staple sections of such products, multiple-purpose machinery forms the backbone of the equipment in any such plant. The more important steps of control in this type of manufacture, therefore, must come after the specific order is received. Planning the exact machines which are to be used in processing an order is dependent both on the operations to be performed and the availability of machines and equipment at a particular time. To use effectively a variety of equipment in processing the various orders, adequately utilizing the time of the equipment and the workers, is a control problem that is made difficult partly because of the pressure under which it must be done after an order is received.

In intermittent manufacture, where product is manufactured at one time, and then again at a later time, it becomes possible to determine the best machinery to do given work, keep an accurate record of this, and then bend every control effort to the utilization of this machinery when the product is again manufactured. Manufacture of this type lends itself to production for stock in profitable manufacturing quantities, and therefore it becomes possible to place manufacturing orders in the plant only when the best possible equipment is available. Furthermore, the time of manufacture can be varied somewhat, which is not the case in variable manufacture direct to customers' orders. In

other respects the control problems of these two types of manufacture are essentially the same.

The differences in control problems caused by the use of general and special purpose machinery may be illustrated by comparing the worsted spinning and fancy cloth weaving (repetitive) with automobile (standard quantity) and diverse machinery industries. In worsted spinning, each bit of wool must go through the same processes to become spun yarn. After preparation, the wool must be carded, combed, drawn, spun and twisted in turn. The capacity of each machine in each department of the plant is known, the machine capacity is balanced and a given amount of raw material, less wastage, will always make approximately a given amount of yarn at the end of the processes. Machines are entirely interchangeable, after being adjusted for a given grade of yarn.

In manufacturing automobiles, although this is an assembly rather than a continuous industry, essentially the same control problems are faced in machine utilization. Thus a crank-case passes from the foundry to a specially constructed milling machine that works on all sides of the crank-case at once, to a special multiple drill that drills as many as sixty-five holes at once, to inspection and to the assembly floor. Again the capacity of each machine and each department is known, the machine capacity is balanced, machines are adjusted for the particular design of cars being produced and the control of parts through a given series of processes is essentially the same as in continuous processing.

Fancy cloth weaving is a continuous industry, repetitive in nature, as is yarn spinning, and yet the control problems of these two industries are essentially dissimilar. Certain types of looms will produce patterns of a certain degree of intricacy, requiring the use of one, or perhaps two, shuttles with different-colored filler yarn. Other looms with multiple shuttles can be used on the more involved patterns. Planned control here cannot rely on an easy balance either of machines or personnel. While other departments of a plant may function readily regardless of the style of goods being made, the weave room will present grave problems of machine utilization, if a prevailing style of fabric requires the use of the more elaborate looms. Similarly, on some styles of fabrics, weavers may be able to tend six looms, while on more intricate fabrics they may be able to tend but three or four. In an industry as subject to style fluctuations as fancy cloth weaving, this presents a control problem which is more that of a diverse machinery industry than that of a repetitive continuous industry.

Plants making diverse machine products have always been utilized as the outstanding example of diverse control problems. That this is so is due to the fact that various products may utilize entirely different

machines in their production. Therefore it becomes very difficult to control operations so that production may meet shipping dates established by sales requirements. This in turn is no easier than planning complete utilization of the time of the several types of equipment, so that idleness costs shall not accrue, or than planning production so that inventories of goods in process shall be reduced to the lowest possible amount.

Difficulties of sales control are also to be met with in repetitive and variable production industries if their problems be compared with those of standard production plants. In the first place, in order to secure a common denominator to use in comparing sales in different classes of product, or in several territories, or over several years, dollars must be used. Units of production do not offer a satisfactory basis for comparison. The dollar is a poor base because its own value shifts. Furthermore in establishing quotas for salesmen, the demands of several territories may be so diverse that a dollar standard will prove of no value either in evaluating effort put forth, or as a basis of commission payment. In selling the capacity of the plant, since units cannot be used, and dollars have little permanent significance, the measure that is usually resorted to is hours of capacity.

Machine hours and department hours of capacity are the measuring sticks that place intermittent or variable production on the same basis as standard production for control purposes. Salesmen can be informed of unsold capacity in each of several general lines and can endeavor to push that type of product, rather than another type. Time can be allocated in the master schedules for each general class of product and time utilized may then be checked against this. However, great care must be exercised in administering this device for control. By the time that salesmen hear of unused capacity, the figure which they have is at best inaccurate. Therefore promises which are made become difficult to live up to without wrenching either the productive mechanism of the plant, or the good-will of the customer. As has been indicated, in repetitive production stocks of goods can be built up, but in product having a style factor, this may become dangerous. In times of hand-to-mouth buying by the outlets which take the product, control over production cannot always be toward customers' orders, but must be toward demand. This means that speculation enters into control, in addition to the more scientific factors that have been mentioned.

Whatever the character of the business, consideration of the financial factor in making production plans indicates that correlation of sales and production really involves finance as well. Thus, control of production cannot be permanent unless it is related, not only to sales, but

to all major factors of a business. Such correlation is usually achieved through the use of a budget, or through the use of statistical data of major importance as a guide in the operation of every portion of a business.[1] The business conditions that affect the business will be flexible, and therefore it is essentially true that flexibility of the budget is one of the more important control concepts that must be held in mind. Coordination of departments as described in the next chapter must be effective before any departmental control, whatever its nature, or whatever the nature of the business, may be expected to function properly.

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[1] Cf. Chapters XI and XIX.

CHAPTER XIX

GENERAL ADMINISTRATIVE CONTROL[1]

In earlier chapters methods of research leading to general administrative standards have been discussed, as have also typical standards resulting from such research.[2] Incidentally in these chapters attention has been necessarily called to the use of standards for purposes of operating control, but only in a general way. The purpose of this chapter is to explain in detail a technique whereby a chief executive may use standards for the purpose of measuring and controlling the work of operating units. Its claim to distinction rests upon the fact that it represents a complete tie-up of standards and control records from the smallest detail of production and sales to those end results with which the chief executive is immediately concerned. It is a system of control records of the nature of a fan which the chief executive can open out to such details as at any time may be desirable. Techniques of this kind are not common, but their practicability and economy have been adequately demonstrated by experience.

There are three basic requirements for a system of general administrative control of departmental operations:

1. An organization in which the things done and the personnel are brought into such relationship that responsibilities do not overlap and are clearly defined.

2. A system of accounts, or of statistical records in accounting form, which permits current posting of the costs of achieving results, segregated into ledger accounts which correspond to units of organization responsibility.

3. A flexible forecasting budget of both revenue and expense—and the difference between these, earnings—of which the detail items, or classified groups of them, correspond to the units of organization responsibility and to the ledger accounts, and serve as standards against which actual performance as indicated by the accounts may be measured; a budget which is a *just measure* because it incorporates into its forecasting the *actual conditions under which results are achieved.*

Organization and Accounts. 1. *Organization.* No two or more men can function together effectively, and no chief executive can appraise and judge the performance of his department heads, without an agreement and understanding concerning the responsibilities and duties

[1] By John H. Williams, Consulting Engineer, New York.

[2] Cf. Chapters IV and XI.

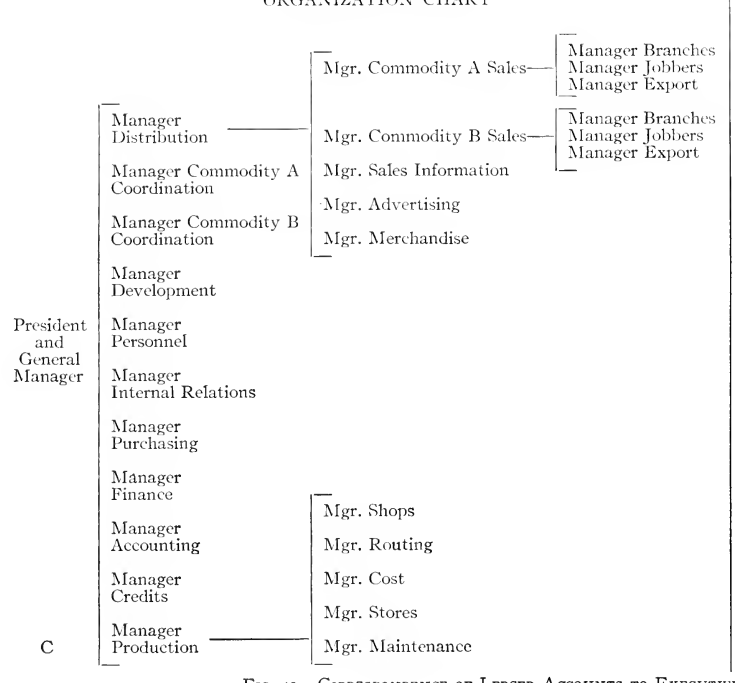

FIG. 40. CORRESPONDENCE OF LEDGER ACCOUNTS TO EXECUTIVE RESPONSIBILITIES

of each. An organization based upon natural groupings of the things to be done as determined by the technical characteristics of the particular enterprise—essentially a functional organization—is the type in which responsibilities and duties overlap least and are most precisely defined and understood.[1] The left half of Figure 40 is an illustrative chart of such an organization.

2. *Accounts.* If the organization outline represents the units of responsibilities and duties upon which the success or failure of the enterprise depends, then obviously it represents the units in which all costs and records should be kept if the chief executive is to exercise an effective control over the situation. An accounting classification made without reference to a classification or determination of the duties or responsibilities concerned, is *prima facie* an ineffective accounting classification for current management purposes. If responsibilities and duties are assigned on one basis and records kept on another, one might as well try to measure with a bushel basket something bought by the pound. That is what is unconsciously being done in many of the best enterprises. Of course most organizations have their accounts so arranged that all expenditures *ultimately* find their way to one or another major responsibility. But what we here have in mind is something different; every expenditure should go *at once* to that organization unit of which the head is responsible for the expenditure, and should stop there. The name of the organization unit and the name of the ledger account should be the same, and no part of any expenditure—rent, interest or any other item not arranged for by the unit head himself—should be prorated to the account for which he is responsible, and no part of any expenditure for which he is responsible should be prorated to the account of some one else. The units for which *individuals are responsible* are the sources of success or failure, and unless records are kept in terms of such sources, general administration has no means of appraising individual unit or individual executive performance. The right half of Figure 40 illustrates ledger accounts which correspond to the units of responsibility listed on the left half of that figure.

The Flexible Budget. A budget in which the forecasted items correspond to the units of organization responsibility and to the ledger accounts, constitutes the standards by which unit performances, as recorded in the accounts, are appraised. But a budget which assumes a given volume of sales, for instance, is not a just standard by which to measure performance as evidenced by costs, if that cost performance has been conditioned by a different volume of sales. Where it is impossible to say very far in advance whether a business of one

[1] Cf. Chapter X.

amount or another will be done, or what a selling price or a price paid for materials will be, a forecasting budget which may serve as a proper standard must be adjustable in varying volume, price and similar particulars of the business, and must be used to measure a responsible individual's performance for a given period only after its adjustment to the business conditions of the period.

So important is this concept of a flexible budget that we take the liberty of using as illustration a case in which multiple budgets—based on different volumes of sales—are constructed. Figure 41 represents

Budget Items	Monthly Expenses of the Unit at Various Volumes of Sales per Year		
	$1,000,000	$2,000,000	$3,000,000
Manager of the Department	$ 417	$ 417	$ 417
Assistant to the Manager			200
Stenographers	115	230	345
File Clerk	80	80	80
Order Clerks	200	300	400
Other Clerks	300	500	700
Supplies	800	1,200	1,700
	$ 1,912	$ 2,727	$ 3,842

Fig. 41. Illustrative Multiple Budget

purposely over-simplified sections of three hypothetical [1] budgets pertaining to a clerical unit in the general offices of a plant.

If a single budget of this unit has been made and it is based on an assumed volume of business of $2,000,000 per year, then the standard of efficiency is an expense of $2,727 per month. But if the sales increase to $3,000,000 per year, the single budget expense standard is only 70 per cent of what it should be. If the sales decline to $1,000,000 per year the single budget expense standard is 142 per cent of what it should be. In short, it remains a just standard only so long

[1] All other exhibits in this chapter are taken from actual records of plants utilizing a flexible budget such as is here described.

as the sales remain approximately $2,000,000 per year. But if a separate budget is computed for a maximum, a minimum and several intermediate volumes of sales, there will be available a measure for the efficiency of the unit even if there are fluctuations in the volume of business. This crude illustration of multiple budgets indicates how useful would be a single budget if it could be made flexible enough to be adjustable to varying volumes of business.

Construction of a Flexible Budget. It is possible to construct such a flexible budget, refined enough for effective use yet simple enough to keep the cost of its establishment and maintenance well within reasonable limits. For the construction of such a budget certain factors have to be kept clearly in mind.

1. *Fixed Cost.* Fixed cost is that part of the total cost in dollars of doing the business contemplated in the budget which exists irrespective of the fluctuations in the volume of business within a range from the smallest volume of business which there is reasonable probability of doing up to the practical capacity of the plant. It represents only such items and parts of items as are regarded essential to the conduct of the business at the established minimum volume and are independent of fluctuation because of increase or decrease (within limits) of the volume of business: rent; depreciation; salary of executive and of a minimum number of accountants and clerks; payroll for shop superintendents, foremen, watchmen, etc.; property and corporation taxes; interest on funded debt; etc. The element of fixed cost for each responsible unit of an organization is computed as a fixed amount per year or month.

2. *Variable Cost.* Variable cost is that part of total cost which varies in proportion to the volume of business. It should represent only such items and parts of items as are not essential to the functioning of the business on the basis of the established minimum: materials; direct wages; supplies; upkeep; salaries of minor executives, accountants and clerks; payroll of assistant shop superintendents, foremen, etc.; income taxes; interest on floating debt; stock dividends; etc. Under conditions of falling volume these items should constitute a schedule for curtailments. This element of cost for any responsible unit cannot be expressed as a fixed amount per year or month, because of fluctuations of volume of business, and must be expressed otherwise, as will be indicated below in paragraph 6.

3. *Contribution to Fixed Cost and Profit.* This is the difference between variable cost and sales value at list. Assuming that for any item produced the variable cost is $.80 per dollar of sales, the contribution to fixed cost and profit will be $.20 per dollar of sales. Fixed cost has a first claim on this $.20 and whatever remains goes to profits.

4. *Sales Quota.* This is an expectation of the number of units of an item or group of items to be sold in a given period or territory or by a particular salesman.

5. *Material and Labor to List.* This is the ratio of the sum of materials cost and direct labor cost to the list price of an item.

6. *Per Cent of Variable Cost.* This is the quotient derived by dividing the difference between maximum sales and minimum sales

COMMODITY A 1: MATERIAL AND DIRECT LABOR COST TO LIST PRICE

Revised to.....

Commodity		List Price		Material Cost		Direct Labor Cost		Mat. & Labor To List
Item	Quota	Unit	Total	Unit	Total	Unit	Total	
A 1 A	25,739	$1.85	$ 47,617.15	$ .6675	$ 17,180.78	$ .3448	$ 8,874.81	.5472
A 1 B	95,390	1.70	162,163.00	.5857	55,869.92	.3411	32,537.53	.5451
A 1 C	101,510	1.55	157,340.50	.4761	48,328.91	.3372	34,229.17	.5247
A 1 D	15,915	1.70	27,055.50	.5858	9,323.01	.3356	5,341.07	.5420
A 1 E	5,773	1.45	8,370.85	.4704	2,715.62	.3078	1,776.93	.5367
A 1 F	31,238	1.35	42,171.30	.3652	11,408.12	.3056	9,546.33	.4969
Total A1	275,565		$444,718.30		$144,826.36 .3256 to List		$92,305.84 .2076 to List	.5332

FIG. 42. SUMMARY OF COMMODITY ITEM STANDARDS

into the difference between the cost of maximum sales and the cost of minimum sales. Maximum sales and minimum sales mean respectively the greatest and the least amount of business there is probability of doing during the period covered by the forecasting budget. To illustrate: if computations determine that $14,000,000 worth of sales will cost $1,710,000 to produce, and $7,000,000 worth of sales will cost $905,000 to produce, then $805,000 (the difference between the costs) divided by $7,000,000 (the difference between the sales) will give .115 or 11.5 per cent of variable cost.

Given the above factors, based upon effective sales research, standards and control, and upon effective production research, standards and control, a flexible forecasting budget may be constructed which permits measurement and appraisal of performance of the various responsible units currently with the development of operations during the period covered by the budget.

The first standards logically to be set in the making of a control budget are those pertaining to the commodity items. These comprise the number of units of each commodity to be sold within the period; the cost price, unit and total; the material cost, unit and total; the

COMMODITY SUMMARY: MATERIAL AND DIRECT LABOR COST TO LIST PRICE

Revised to.....

Group	Sales at List	Material Cost		Labor Cost		Material and Labor
		Amount	Per Cent	Amount	Per Cent	
A 1 etc.	$ 444,718	$ 144,826	.3256	$ 92,305	.2076	.5332
B 1 etc.	4,000,000	1,347,000	.3367	850,000	.2125	.5492
C 1 etc.	3,000,000	700,000	.2333	618,000	.2060	.4393
Total	$30,000,000	$7,500,000	.2500	$6,000,000	.2000	.4500

FIG. 43. SUMMARY OF COMMODITY GROUP STANDARDS

direct labor cost, unit and total, and the ratio of materials and labor cost to list price. These, as is the case with all standards, should not be guesses; they should be calculated, reasonable expectancies. The purpose of setting standards is to determine a reasonable expectancy under conditions which should and can be made to exist as constituting a yardstick by means of which one may measure the degree of effectiveness of the individuals to whom certain responsibilities and duties have been assigned. The sheet pertaining to a class of items identified as A 1 may appear as in Figure 42.

Sheets on which the group totals for all commodity groups are summarized may appear as in Figure 43.

The standards logically next in order of construction are those per-

ORGANIZATION UNIT: Manager Commodity A Jobbers
LEDGER ACCOUNT: Manager Commodity A Jobbers
SCOPE OF EXPENDITURE: Supervision and Direction of Sales of Commodity A to Jobbers
BASIS: *Minimum Sales at List* $7,000,000; *Maximum Sales at List* $14,000,000
STANDARD: *Fixed Cost per Month* $8,333; *Variable Cost* 11.50 per cent *of Sales at List*
DATE MADE 12/5/20 BY H. E. C. APP. C. L. B. AUTHORIZED L. P. K.

Items	Cost for Minimum Sales				Cost for Maximum Sales			
	Employment	Physical	Service	Total	Employment	Physical	Service	Total
Jobbers' Discount 10%			700.0	700.0			1,400.0	1,400.0
Bad Debts 0.1%			7.0	7.0			14.0	14.0
Rebates & Allow. 0.1%			7.0	7.0			14.0	14.0
1 Manager	12.0			12.0	12.0			12.0
3 Ter. Supervisors	15.0			15.0	15.0			15.0
4 Secretaries	7.0			7.0	7.0			7.0
5–10 Clerks	8.0			8.0	16.0			16.0
1–2 Boys	.5			.5	1.0			1.0
9–12 Salesmen	45.0			45.0	60.0			60.0
Off. Supplies, Stores		1.0		1.0		1.5		1.5
Off. Supplies, Special		2.0		2.0		3.0		3.0
Job. Sales Literature		30.0		30.0		48.0		48.0
Postage			3.0	3.0			6.0	6.0
Telegraph			2.0	2.0			4.0	4.0
Sales Travel			22.0	22.0			29.0	29.0
Executive Travel			5.0	5.0			5.0	5.0
Sales Bonuses	21.0			21.0	42.0			42.0
Executive Bonuses	14.0			14.0	28.0			28.0
Miscellaneous			3.5	3.5			4.5	4.5
Total	122.5	33.0	749.5	905.0	181.0	52.5	1,476.5	1,710.0
			(Expressed in thousands)					

FIG. 44. SUMMARY OF STANDARDS OF AN OPERATING UNIT

tinent to the work of responsible operating units. Figure 44 shows the form containing the standards of the unit for which the manager of sales of commodity A to jobbers is responsible.

The author's particular use of the terms "Employment," "Physical," and "Service" in this sheet should be explained. This division of costs presents the items of which we necessarily think in connection with the functioning of an organization; it avoids artificial subdivisions containing a variety of elements. Any division of expenditures would necessarily include the following: the individuals necessary to carry out the work; the physical things consumed in doing the work; the services of one kind or another rendered by outside agencies for which payment must be made. Therefore "Employment" covers salaries, commissions and bonuses of every kind from chief executive to laborer and office boy, when paid to an individual regularly employed by the company. "Physical" covers all physical things purchased outright and consumed or disposed of in the conduct of the business, such as raw and manufactured materials, supplies, printed matter and stationery. "Service" covers such things as royalties, rents, interest, discounts, telephone, telegraph, transportation, food and lodging.

A sheet summarizing the standards for all major operating units is represented by Figure 45.

The first column in this figure is a list both of responsibilities and of ledger accounts. The figures under "Range" are derived from detailed sheets, such as Figures 42 and 44—one for each organization unit and commodity. The figures under "Cost Standards" are computed from those under "Range" by the formula for variable cost previously explained, as follows: (Column D — Column B) ÷ (Column C — Column A) = per cent of variable cost; (Column B — Column A) × Column G = fixed cost; and (Column C × Column G) + Column E = Column D. The purpose of the variable cost formula is to enable one to determine the dividing line between fixed cost and variable cost. In other words, given the total minimum and total maximum cost for the conduct of an enterprise or any unit of it, the formula furnishes a means whereby one may determine what part of such cost is fixed and what part is variable within the meaning of these words previously explained.

It should be observed that in Figure 45 figures are entered for only part of the items. The figures $15,000,000 and $30,000,000 in the two columns headed "Sales" are the respective minimum and maximum volumes of sales, and are constants which should not be added to or subtracted from other figures. The figures for materials and direct labor are taken from Figure 43; these, fluctuating uniformly with the volume of business, represent variable cost only, and since the per cent

OPERATING STANDARDS—for Period January 1st, 1921,
to.....
(Expressed in Thousands)

	Range				Cost Standards		
	Minimum		Maximum		Fixed		Per cent
	Sales	Cost	Sales	Cost	Year	Month (Dollars)	Variable
MANAGEMENT	15,000	3,250	30,000	4,000	2,500	208.333	.0500
Pres. & Gen. Mgr. Com. A. Cor. Com. B. Cor. Development Personnel Int. Relations Purchasing Finance Accounting Credits							
PRODUCTION	15,000	10,000	30,000	17,500	2,500	208.333	.5000
Overhead	15,000	3,250	30,000	4,000	2,500	208.333	.0500
Production Shops Routing Cost Stores Maintenance							
Materials (F)	15,000	3,750	30,000	7,500	None	None	.2500
Direct Labor (F)	15,000	3,000	30,000	6,000	None	None	.2000
DISTRIBUTION	15,000	3,250	30,000	5,500	1,000	83.333	.1500
Overhead	15,000	635	30,000	1,070	200	16.667	.0290
Distribution Sales Infor. Advertising Merchandise							
Com. A Sales	9,250	19	18,500	28	10	.833	.0010
Branches	2,000	490	4,000	770	210	17.500	.1400
Jobbers (G)	7,000	905	14,000	1,710	100	8.333	.1150
Export	250	57	500	94	20	1.667	.1480
Com. B Sales	5,750	16	11,500	22	10	.833	.0010
Branches	4,000	840	8,000	1,280	400	33.333	.1100
Jobbers	1,000	175	2,000	330	20	1.667	.1550
Export	750	113	1,500	196	30	2.500	.1107
TOTALS	15,000	16,500	30,000	27,000	6,000	500.000	.7000
Column No.	A	B	C	D	E	F	G

Per cent Variable Cost—(D minus B) divided by (C minus A) = G
Fixed Cost—B minus (A multiplied by G) = E
Proof—C multiplied by G plus E should equal D

FIG. 45. SUMMARY OF STANDARDS OF MAJOR OPERATING UNITS

of these figures with reference to sales was determined in Figure 43, it is necessary only to fill in the per cents in the last column under "Cost Standards." There being no fixed cost in connection with material or direct labor, no figures should be entered under "Fixed" for these variable items.

It should readily be observed how all the figures under "Cost Standards" can be computed from those under "Range." Given the figures under "Range," the per cent of variable sales is computed by the formula (maximum cost — minimum cost) ÷ (maximum sales — minimum sales) = variable cost. Having computed the per cent of variable cost, then (minimum cost) — (per cent variable sales × minimum sales) = fixed cost. When these figures have been computed and added up, we have the total cost for the conduct of the enterprise subdivided into the units of responsibilities and duties upon which the activities of the enterprise are based. These figures give general administration positive information: that variable cost of the total business should be $.70 per dollar of sales, and fixed cost, $6,000,000 per year; that sales amounting to $20,000,000 must be secured to break even;[1] that thereafter every dollar of sales should yield $.30; and in addition it is known *exactly what part each responsibility must play to obtain these results.*

Observe the simplicity of the accounting required. Subdivision of expenses as between a number of different accounts is done away with; rent is charged to the organization unit responsible for relations with lessee; insurance to the unit responsible for relations with the insurance agent; and so on. The only journal entries to be made at the end of a month before an operating statement can be made are those which are common at the end of every month—such as depreciation and fixed charges. Therefore if all expenditures clear through a voucher register, as can easily be arranged, there is no need for waiting beyond the writing up of the first entry books to secure figures corresponding to each of the standards presented in the summary. All that is necessary to make an operating statement is the amount of the debit and credit charges for the month subdivided according to the organization units responsible for the transactions out of which they have grown.

This covers the three basic principles which should underlie any method of management through which the chief executive can exercise effective control:

[1] Fixed cost is known to be $6,000,000; per cent of variable cost is known to be 70; let x = necessary sales to break even. Then by hypothesis—

$$x = 6{,}000{,}000 + .7x$$
$$.3x = 6{,}000{,}000$$
$$x = 20{,}000{,}000$$

ORGANIZATION UNIT: Manager Commodity A Jobbers. LEDGER ACCOUNT: Manager Commodity A Jobbers
SCOPE OF EXPENDITURES: Supervision and Direction of Sales of Commodity A to Jobbers
VARIATION FROM STANDARD: $8,333 per month Fixed Cost and 11.5 per cent Variable Cost

Months	Sales		Actual Cost		Standard Cost		Variation to Date			
							Good		Bad	
	Month	To Date	Month	To Date	Month	To Date	Amount	Per cent	Amount	Per cent
Jan.	1,000,000	1,000,000	122,333	122,333	123,333	123,333	1,000	.0010		
Feb.	1,000,000	2,000,000	126,333	248,666	123,333	246,666			2,000	.0010
Mar.	750,000	2,750,000	98,583	347,249	94,583	341,249			6,000	.0022
Apr.	1,000,000	3,750,000	128,333	475,582	123,333	464,582			11,000	.0030
May	750,000	4,500,000	100,583	576,165	94,583	559,165			17,000	.0038
June	1,000,000	5,500,000	128,333	704,498	123,333	682,498			22,000	.0040
July	500,000	6,000,000	76,833	781,331	65,833	748,331			33,000	.0055
Aug.	1,000,000	7,000,000	129,333	910,664	123,333	871,664			39,000	.0056

Fig. 46. Operating Statement of an Organization Unit

1. The expression of all results in common terms. That is, the statement of the chief executive is literally merely a copy of the last lines of the statements of those to whom he has delegated responsibilities and duties, brought together.

2. The classification of expenditures according to responsibility for each transaction out of which they have grown, as distinguished from the nature of the expenditure itself.

3. The establishment of flexible standards which are readily adjusted to changing conditions in volume of business, price of product and cost of material and labor.

Use of the Flexible Budget. Given the current records yielded by such a flexible budget as has been constructed in this chapter, the general administration of an enterprise can have prepared from them such special analyses, reports and other control documents as seem desirable. We shall call attention to four such possible reports.

1. *Unit Operating Reports.* Figure 46 is an operating statement for an organization unit—that unit responsible for the sales of commodity A to Jobbers.

The figures for "Sales" are derived from the sales book, and the figures for "Actual Cost" by adding the corresponding column in the voucher register book. It is not necessary to wait for journal entries to be made, the ledger to be posted or a trial balance to be taken off. The data for "Standard Cost" have been derived from Figure 45, where the fixed cost for this unit is found to be $8,333 per month and the variable cost 11.5 per cent of sales.

Examining the figures for January we find the sales to be $1,000,000. Therefore the variable cost should be $115,000 (.115 × $1,000,000). Adding the fixed cost ($8,333) the standard cost for the achieved volume of sales is $123,333. The actual cost is $122,333; therefore the unit has bettered standard by one-tenth per cent. Variations "To Date" can be computed by adding the standards for the various months, or by taking 11.5 per cent of the sales to date and adding the fixed cost multiplied by the number of months. In the months subsequent to January, costs run a fraction of a per cent to the bad as compared with standard. This is a signal to examine the actual conditions of the sales of this unit, discover the unfavorable influences at work and correct them.

2. *General Operating Reports.* Figure 47 is a summary report for all operating units. Reference to explanations of Figures 45 and 46 should make its items, arrangement and figures understood without further explanation. We desire rather to give attention to its significance; how much more it is informing and useful as a control instru-

OPERATING REPORT—7 MONTHS TO AUGUST 31ST, 1921

(Expressed in Thousands)

	Sales At List	Cost		Variation		Per cent Variable Cost	
		Actual	Standard	Good	Bad	August	Standard
MANAGEMENT	16,000	2,447	2,467	20		.0487	.0500
Pres. & Gen. Mgr. Com. A. Cor. Com. B. Cor. Development Personnel Int. Relations Purchasing Finance Accounting Credits							
PRODUCTION	16,000	9,767	9,667	50	150	.5062	.5000
Overhead	16,000	2,517	2,467		50	.0531	.0500
Production Shops Routing Cost Stores Maintenance							
Materials	16,000	3,950	4,000	50		.2469	.2500
Direct Labor	16,000	3,300	3,200		100	.2062	.2000
DISTRIBUTION	16,000	3,170	3,066	21	125	.1565	.1500
Overhead	16,000	613	597		16	.0300	.0290
Distribution Sales Infor. Advertising Merchandise							
Com. A Sales	9,250	21	16		5	.0015	.0010
Branches	2,000	428	420		8	.1440	.1400
Jobbers	7,000	911	872		39	.1206	.1150
Export	250	50	51	1		.1420	.1480
Com. B Sales	6,750	19	13		6	.0019	.0010
Branches	5,000	877	827		50	.1200	.1100
Jobbers	1,000	148	168	20		.1350	.1550
Export	750	103	102		1	.1119	.1107
SALES	16,000	15,384	15,200	91	271	.7114	.7000
COST	15,384						
PROFIT	$ 616	Equal to increase in Net Assets as shown on ASSETS AND LIABILITY STATEMENT.					

FIG. 47. SUMMARY REPORT OF ALL OPERATING UNITS

ment than the conventional operating report. The conventional operating report may give information of various kinds relative to operations of the current month, of the corresponding month of the previous year, cumulative for the current year, cumulative for the corresponding months of the preceding year, and so on. But what particular control value is derived from a comparison of January this year with January last year? In such comparison there is not even remotely a standard of measurement; industrial conditions may have changed, sales prices may have changed, materials may have gone up or down and wage adjustments may have been made during the interval between one January and another.

On the other hand, in the operating report illustrated by Figure 47, achievement is measured by comparison of the actual costs of such achievement with the predetermined standard costs for the period covered by the report on the basis of the business conditions—particularly the volume of sales—as they actually existed. In the illustration it is obvious that there have been unfavorable influences during the period covered. The cost of management and the cost of materials have been favorable—no troubles there. Production overhead is $50,000 and direct labor is $100,000 to the bad—undoubtedly a general wage increase which it was expected would influence the operating report. But in sales there are discrepancies which must be investigated and explained. Perhaps they can be corrected; perhaps the standards must be revised. In any case general administration can go straight to the examination of the spots showing trouble and the resultant knowledge gives control of the situation.

The question may be raised whether a statement made up in this way will check with the financial accounts. Let us see what has been done. First, expenditures have been divided according to the unit authorizing them; second, every penny of expenditure has been left where it was first charged. There has been no diverting of expense from one account to another. Instead of having been complicated, accounts have been simplified. All that is necessary to do is to add up gross revenue, add up the actual expenses and deduct one from the other; the difference is necessarily profit and loss (see foot of first column). There is here less detail work than in any other procedure which makes even a pretense of giving accurate monthly figures.

Of course there must be adjustments to meet known variations from assumed conditions. Assume that the amount of goods produced does not happen to be the same as the amount sold. If production has been, for instance, $100,000 list price in excess of sales, the excess production at inventory cost should be added to the profit as shown:

Profit as shown on operating statement	$616,000
Value of goods produced in excess of those sold ($100,000 × .55)[1]	55,000
	$671,000

If sales have been $100,000 list price in excess of production, the value of the goods sold in excess of those produced should be deducted from the profit as shown:

Profit as shown on operating statement	$616,000
Value of goods sold in excess of those produced ($100,000 × .55)	55,000
	$561,000

3. *Commodity Reports.* Figure 48 illustrates a report which gives the following information with respect to the two commodities A and B: inventory cost—the net cost of commodities available for distribution; basic sales cost—inventory cost plus the cost of general sales organization; branch sales cost—total cost of commodities sold through company's own branches; jobbers sales cost—total cost of commodities sold through jobbers; export sales cost—total cost of commodities sold for export. It should be recalled that sales values are based on list prices rather than on net sales prices and that discounts are treated as expense in making up the various elements of the budget. This treatment is for the purpose of preserving comparability in the face of the fact that discounts are not uniform for the various channels. By preserving comparability the relative merits of various channels of distribution may be appraised.

All the figures on this statement refer to variable cost, but because the fixed cost for each item and the total fixed cost ($6,000,000) are known, it is possible to compute the effect upon profit and loss which any major change in policy would make.

For instance, what would be the effect of a 5 per cent reduction of the price on commodity B with the expectation of increasing the sales by $2,000,000? The per cent of variable sales is (in round numbers) 70, which leaves $.30 contribution to fixed cost and profit per dollar of sales, of which the total for this commodity is $6,750,000 (Figure 47). By reducing the price 5 per cent ($.05 per dollar of sales), we would lose $337,500 on present sales (.05 × $6,750,000) and gain $500,000 on the additional sales (.25 × $2,000,000), a net gain of $162,500. Again for illustration: what would be the result if the cost of material and labor generally were increased 10 per cent? Material

[1] .55 is the variable cost of management (.05) plus the variable cost of production (.50).

and labor are 45 per cent of total variable cost (.25 + .20 in Figure 47), and an increase of this item by 10 per cent would reduce the amount applicable to fixed cost and profit by $.045 per dollar of sales.

OPERATING SUMMARY EXPRESSED IN PER CENT OF SALES AT LIST

7 Months to August 31st, 1921

Elements	Commodity A		Commodity B	
	Standard	Actual	Standard	Actual
Management	.0500	.0487	.0500	.0487
Production Overhead	.0500	.0531	.0500	.0531
Materials	.2500	.2469	.2500	.2469
Direct Labor	.2000	.2062	.2000	.2062
INVENTORY COSTS	.5500	.5549	.5500	.5549
Distribution Overhead	.0290	.0300	.0290	.0300
Commodity Sales Supervision	.0010	.0015	.0010	.0019
BASIC SALES COST	.5800	.5864	.5800	.5868
Branch Sales Supervision	.1400	.1440	.1100	.1200
BRANCH SALES COST	.7200	.7304	.6900	.7068
Basic Sales Cost	.5800	.5864	.5800	.5868
Jobbers Sales Supervision	.1150	.1206	.1550	.1350
JOBBERS SALES COST	.6950	.7070	.7350	.7218
Basic Sales Cost	.5800	.5864	.5800	.5868
Export Sales Supervision	.1480	.1420	.1107	.1117
EXPORT SALES COST	.7280	.7284	.6907	.6985

Fig. 48. Summary of Information Concerning Specific Commodities

The sales being $16,000,000, the loss from such an increase in materials and labor cost would be $720,000 per year. In a similar manner the effects of other changes in conditions or policy can be computed.

4. *Financial Forecasts.* Perhaps, because most unusual, the most interesting document for control made possible by the flexible budget is a forecast of profit and loss, bank balance and credit position. Unfortunately finance is too often regarded as separate from operating. Records show that many of the difficulties of both large and small concerns alike result from operations on a scale beyond financial resources. Under ordinary methods of accounting it is difficult to forecast the financial effects of operations, but with standards available such as those contained in Figure 45, the financial results on any basis of operation are easy to determine. Not only the profits and losses to be expected, but also the bank balances and credit positions for some months ahead, can be determined. Such forecasts are valuable on the one hand in helping to determine a program of operations, and on the other hand in arranging credit requirements with the bank.

Figure 49 is such a document—actually a forecasted balance sheet for a period of six months representing the financial effects of operations on the basis of maximum sales given in Figure 45. To make this financial forecast it is necessary to know, in addition to the information contained in Figure 45, the subdivision of sales by months, already made in connection with the sales quota, and the experience of the company in the matter of collections of accounts receivable.

The items in the first column represent the major divisions of responsibilities and duties used throughout this chapter—Management, Production, and Distribution. Under each of these are listed those items through which these major responsibilities affect the financial statement.

The second column headed "Dec. 31" represents the status of the company on the date the forecast balance sheet is made, the figures being taken from the financial statement of that date. The last column headed "July 1" is the forecasted balance sheet as of the end of the six-month period. In the double columns, each representing a month, the letters A and C symbolize assets and collections respectively, and the letters L and P symbolize liabilities and payments respectively.

Dealing with the assets, the first item under Management is Bank Balance. This shows as an asset on December 31, and as both an asset and collection in each succeeding month. In making a forecast on a prescribed basis it often happens, as in this case, that instead of a bank balance, there is a bank deficiency. A deficiency is shown under Liabilities. The second item is Notes Receivable. They are shown as an asset on December 31, and in each month up to the date of payment when they appear also as a collection and thereafter disappear. The third item is Accounts Receivable. They are shown as an asset on December 31, and in lesser amount in each succeeding month accord-

FORECAST OF PROFIT AND LOSS, BANK BALANCE AND CREDIT POSITION
(Expressed in thousands)

RESPONSIBILITIES AND LEDGER ACCOUNTS	DEC. 31	JAN.		FEB.		MCH.		APR.		MAY		JUN.		JULY 1
ASSETS	A	A	C	A	C	A	C	A	C	A	C	A	C	A
MANAGEMENT														
Bank Balance	500	500	500			743	743			161	161	95	95	1,594
Notes Receivable Due Feby.	200	200		200	200									
" " " Apr.	300	300		300		300		300	300					
" " " June	600	600		600		600		600		600		600	600	
Accounts Receivable Dec. 31	5,400	5,400	3,000	2,400	1,800	600	600							
" " January		2,000		2,000	800	1,200	800	400	400					
" " Feby.				2,000		2,000	800	1,200	800	400	400			
" " March						3,000		3,000	1,200	1,800	1,200	60	600	
" " April								2,500		2,500	1,000	1,50	1,000	500
" " May										3,000		3,000	1,200	1,800
" " June												2,500		2,500
Income from Outside Investments		200	200					200	200					
Discount on Purchases		10	10	10	0	10	10	20	20	20	20	10	10	
Fixed Capital	15,000	15,000		15,000		15,500		16,000		16,000		16,000		16,000
PRODUCTION														
Materials and Work in Process	4,000	3,900		3,800		3,700		3,600		3,500		3,400		3,400
Finished Products	5,000	5,300		5,600		5,300		5,300		5,000		5,000		5,000
Total Assets and Collections	31,000	33,410	3,710	31,910	2,810	32,953	2,953	33,120	2,920	32,981	2,781	32,705	3,505	30,794
Total Liabilities and Payments	31,000	33,050		31,390	2,067	32,073		31,770	2,759	31,261	2,686	30,725	1,911	28,814
Net Profit and Bank Balance		360		520	743	880		1,350	161	1,720	95	1,980	1,594	1,980
LIABILITIES	L	L	P	L	P	L	P	L	P	L	P	L	P	L
MANAGEMENT 20.8+5%														
Bank Deficiency				31	31			198	198					
Notes Payable Due Jany. 10	1,000	1,000	1,000											
" " " Mch. 5	1,000	1,000		1,000		1,000	1,000							
Accounts Payable Dec. 31	800	800	600	200	200									
Increases to Fixed Capital						500		1,000	5,000	500	500			
Capitalization	20,000	20,000		20,000		20,000		20,000		20,000		20,000		20,000
Surplus	7,145	7,145		7,145		7,145		7,145		7,145		7,145		7,145
Fixed Charges	150	200	150	100		150		200	150	100		150		150
Interest		15	15	15		30	15	30		45		60		60
Operating	50	293	243	293	243	343	293	318	268	343	293	318	268	50
PRODUCTION 20.8+50%														
Materials	625	1,150	625	1,050	525	1,050	525	1,050	525	1,050	525	1,050	525	525
Labor		500	500	500	500	500	500	500	500	500	500	500	500	
Depreciation		100		200		300		400		500		600		600
Operating	80	313	233	313	233	313	233	313	233	313	233	313	233	80
DISTRIBUTION 84+15%														
Discounts		200	200	200	200	300	300	250	250	300	300	250	250	
Reserves	125	174	40	183		282	150	266		305	200	179		179
Operating	25	100	135	160	135	160	135	160	135	160	135	160	135	25
Total Liabilities and Payments	31,000	33,050	3,741	31,390	2,067	32,073	3,151	31,770	2,759	31,261	2,686	30,725	1,911	28,814
Total Assets and Collections			3,710			73	2,953							
Net Loss and Bank Deficiency			31				198							

FIG. 49. BALANCE SHEET FORECASTING FINANCIAL EFFECTS OF OPERATIONS SIX MONTHS IN ADVANCE

ing to probable collections, computed on the basis of experience. The amount collected in each month is entered as a collection and the balance carried forward as an asset to the succeeding month. The expected sales and collections for each month are entered as accounts receivable and dealt with in the same way, each on a separate line. The fourth item is Income from Outside Investments. These appear both as an asset and a collection in the month in which they are received. The fifth item is Discount on Purchases. These also appear both as an asset and a collection in the month in which the discount is charged. The sixth item is Fixed Capital. This appears in a lump sum as an asset under December 31, and also in increased or decreased amount as it may be added to or taken from in each month thereafter. The first item under production is Materials and Work in Process. This appears as an asset on December 31, and in each succeeding month in increased or decreased amount according to the differences between the material and labor put into work and that represented by the work completed. In this exhibit we have assumed that the inventory will be reduced $100,000 in each month. The second item is Finished Products. These are shown as an asset on December 31, and in each succeeding month in increased or decreased amount according to the difference between production and sales. In this case production is assumed to be maintained on a uniform basis sufficient to take care of $2,500,000 of sales at list in each month, whereas the sales are assumed to vary as indicated under Accounts Receivable. The variation in Finished Products is, therefore, 55 per cent of the difference between $2,500,000 and the sales.

Dealing with Liabilities, the first item under Management is Bank Deficiency. This has already been explained under Assets. Notes and Accounts Payable are dealt with in the same way as Notes and Accounts Receivable. Increases to Fixed Capital are shown as a liability in the months in which they will be incurred, and corresponding amounts are added to Fixed Capital as an asset. They are entered as a payment in accordance with the terms of payment for the assets acquired. Capitalization, representing the entire funded obligations of the company, is shown in one lump sum as a liability on December 31 and in each month thereafter. Surplus is shown in the same way. Fixed Charges are shown as a liability to the extent of $50,000 in each month. They are shown as a payment in January and April. The January payment represents a dividend from funds available December 31. A like amount is shown as having been accumulated for payment in July. Interest is shown as a liability to the extent of $15,000 in each month. It is shown as a payment in such amount and such months as may be needed. Operations is an item representing

the current expenses of operating the group organization units coming under the general head of Management. The amount is shown under Liabilities in each month and also under Payment as circumstances may require. Under Production, Materials are figured as a liability at 25 per cent of the monthly production quota of $2,500,000 at list. As Materials and Work in Process as an asset are reduced $100,000 in each month, this amount is also deducted from $625,000 which otherwise would have been used. Payment for these materials is figured as being made in each succeeding month. Labor is figured as a liability at 20 per cent of the sales quota. Payment is figured as being made in the same month. Depreciation is figured as a liability at $100,000 in each month and is allowed to accumulate throughout the period. Operations is an item representing the current expenses of operating the group of organization units coming under the general head of Production. The amount is shown under Liabilities in each month and also under Payment as circumstances may require. Under Distribution, Discounts are figured as a liability and as a payment at 10 per cent of the sales in each month. Reserves are figured as a liability at a fixed percentage of sales in each month. Payment is figured as being made in varying amounts from month to month as commissions and one thing and another for which the reserve is made become payable. Operations is an item representing the current expenses of operating the group of organization units coming under the general head of Distribution. The amount is shown under Liabilities in each month and also under Payment as circumstances may require. The Assets and Collections and the Liabilities and Payments are then added and the one deducted from the other, showing, as the case may be, Net Profits and Bank Balance under Assets, or Net Loss and Bank Deficiency under Liabilities.

I have purposely made this hypothetical forecast of such a nature that it shows bank deficiencies in certain of the months, so that one may get a sense of how unfavorable features of any proposed basis of operation will be shown up by making a statement of this character. With this statement before one, it is evident that one must either arrange for further loans at the bank or for making more prompt collections. This of course means revising the forecast on the basis of the new arrangements. In practice, a shortage of cash in January would have shown up in a similar statement made prior to December 31, and provisions for meeting this condition would previously have been made.

Because of its simplicity it is possible to make statements like this monthly. Through them a firm control of the business is acquired by advance knowledge of the financial consequence of current policies and operations or of proposed changes in these.

The conventional budget is analogous to an automobile speedometer which has a single dial indicating cumulative distance. It enables one to judge how well one has done after the trip is over and it is too late to modify the speed and other conditions and influence the outcome of the trip. The flexible budget is analogous to a speedometer which has also a dial indicating the rate of speed; it enables one to ascertain the rate of accomplishment and to take measures to influence the result in the course of the trip.

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CHAPTER XX

CONTROL OF SALES OPERATIONS[1]

THE following are the most important elements of the problem of control of sales operations:

I. Control of districts
   1. Current operations
   2. Selection of managers
   3. Training of managers
   4. Compensation of managers
II. Control of salesmen
   1. Reports
   2. Selection
   3. Training
   4. Compensation
III. Sales promotion
   1. Selling by mail
   2. Advertising—written or spoken
   3. Demonstration
   4. Gaining dealer cooperation
   5. Coordination with sales force

Control of Districts. 1. *Current Operations.* By constant touch with the work of each district through visits of appropriate frequency and through reports in all necessary detail, home-office executives will guide and help their current operations. They will strengthen weaknesses, as the latter become evident, by intradistrict or interdistrict allocations of men, or by providing special means of education and inspiration. It is often possible in larger sales organizations to have specialists at the home office who can be assigned wherever there is special need both to sell and to train resident salesmen. In any active selling organization new methods and new possibilities will be constantly disclosing themselves in different parts of the field, and the general sales executives must keep close enough to the work to know and judge of them and see that proper knowledge of them is given to all districts. It is especially worth while to select certain districts as areas in which to carry out experiments. In this way several different methods or devices may be studied and tested at the same time, and at

[1] By John S. Keir, Economist, and Henry S. Dennison, President, the Dennison Manufacturing Company, Framingham, Mass.

small cost in money or disturbance. Foreign districts deserve particularly close study, since the variations in conditions met in them sometimes encourage an originality not easy to keep alive in the more routine work of home districts.

2. *Selection of Managers.* Of greatest importance to good district management is the quality of the district manager. He must therefore be chosen with great care and with particular reference to his managerial abilities. Selling ability alone is not enough. The best salesman sometimes makes a very poor manager. Since no tests have as yet been worked out to disclose managerial ability, it is wise to make practical tests of promising salesmen in a variety of ways, such as committee service, small jobs of market analysis, the training of a junior salesman, assistant managership or the charge of a suboffice. If districts vary in size, some of the smaller can be used as testing and training fields.

3. *Training of Managers.* The training of district managers goes on all the time, not the least important part of it, if wisely done, being through their own training of their salesmen. Starting with a manual which carries all standard practice for districts, home-office executives will by their visits and letters constantly build up the managerial abilities and strengthen the weaknesses of their district managers. But these managers can also gain from each other strength which they can get in no other way. Hence arrangements should be made for them to meet in central or regional conferences at appropriate intervals. There is an understanding and inspiration to be obtained from visits to the home office or to a principal manufacturing plant which good management cannot well afford to lose. In the Dennison Manufacturing Company, managers half the world away must come to the plant once every three to five years, and domestic managers at least once every two years.

4. *Compensation of Managers.* The form of compensation to a district manager is to be chosen with regard to its effect on him and also upon his men. Not only must evils be avoided such as arose from the old systems of subcontracting, but a real motive should exist for the district manager to develop his men to their fullest capacities and to build in them a true allegiance to the whole company. District managers usually have an influence on profits greater than that exerted by sales alone; hence they often have some form of profit sharing. To avoid too narrow a motive to build up the district alone, their profit sharing is usually based, in considerable part at least, upon the showing of the company as a whole.

Control of Salesmen. 1. *Reports.* Within any district the district

manager's relationship to the individual salesman is more one of leadership than of detailed and specific direction.

The salesman is assigned to a particular territory which may be designed to cover a certain geographic area or only certain classes of customers within an area. His traveling within that area is as yet in general practice controlled only in a very general way. As knowledge advances, however, the laying out of a more rigid time schedule for individual salesmen becomes more common.

Routine control of salesmen is therefore exercised most often at the present time through frequent reports from him, such as:

a. A daily report on the number of calls.

b. A daily report on the sales resulting from the calls made.

c. A daily report on orders lost.

d. A daily report on the time spent in towns, in traveling, with customers.

e. A daily report of expense in proper detail.

Anything out of the usual routine has to secure the approval of the district manager, who can make each case an opportunity for constructive suggestion or let it lapse into a merely routine operation.

Just as home-office executives visit districts at appropriate intervals, so each district manager spends some time every year with each of his salesmen on the actual work of selling to the customer. At frequent intervals he will make a practice of going over with each salesman his daily experience or his experiences on an extended trip, and assist him in the laying of plans for his calls upon difficult customers.

Records and comparisons are kept by the district or home office for each salesman. These cover a wide range of customer and trade information and summaries of the salesman's work. A full analysis of such records can yield a great mass of information about any particular salesman besides the obvious facts of gross sales, orders lost, orders sold and number of calls per unit of time. For example:

How much does he use the information about trades and customers that is available in the district office?

How does he cooperate with the district management and the home-office management? Objective evidence of this cooperation is found in the demands he makes for special services, for price concession, for leniency in collection of bills, and for other equipment which will make selling less hard for him but much more difficult for the management to coordinate into its major preplanning programs.

How does he cooperate with his customers? Objective evidence on this score may be found in the type of merchandise and the quantities of merchandise sold to individual customers at particular times,

as well as in the more objective demonstration of uses of the merchandise and use of such customer's aid material as may be supplied by his organization.

The orderly accumulation of salesmen's records, checked by field studies, will sooner or later give a basis for standards of performance in calls, sales and expense under various circumstances, which will allow of more refined measures of a salesman's worth than sales alone can give.

2. *Selection of Salesmen.* The sources of supply of salesmen can in general be classified into two groups: within and outside the organization.

The selection of a salesman is affected by a variety of characteristics of the applicant, such as age, health, education, experience, personal appearance, moral character, personality, industry, resourcefulness and tact. Some of these characteristics are objective while others are purely subjective. The methods of attempted evaluation are a medical examination, a mental examination of one sort or another, the completion of an application blank and a personal interview or series of interviews. Objective data are more amenable to standard analysis.

The determination of the physical condition of any applicant for a position is a growing custom in industry. The objections of an earlier day are quite rapidly passing into the discard. The value of such examinations is susceptible of proof by statistical evidence and a great deal of such evidence is available. The job of selling has as much to gain from physical examinations as have factory or office jobs.

The case for mental tests is not quite so evident. Executives have had both too little faith and too much faith in the efficacy of these examinations. They are a valuable piece of supplementary evidence at the present time, and they can be made more and more useful by perfection through constant experimentation.

The application blank is valuable in checking the impressions gained in the personal interview. The blank itself has been the subject of a great deal of study, as has also the interpretation of the factual data contained on it. A copy of the application blank used by the Dennison Manufacturing Company is illustrated by Figures 50 and 51.

The personal interview is the most important single step in the process of selecting salesmen. Usually it is good practice to have more than one interview with promising applicants, and it is always wise to register the impressions of the interviewer after each one. A carefully prepared interview schedule is valuable both to help in making a record after the interview and to prevent important points being overlooked, although care must be exercised to avoid a stilted questioning and explanation. The interview must cover important facts about

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APPLICATION FOR SELLING POSITION

WITH

Dennison Manufacturing Co

AT

_____

Date _____ 19__

1. Name _____ Tel. No _____

2. Home Address. Street _____ City _____ State _____

3. Local Address. Street _____ City _____ State _____

4. Date of Birth. Month _____ Day _____ Year _____ 5. Where Born. City _____ State _____

6. Single ____ Married ____ 7. Totally Dependent. No. of Children ____ Others ____ No. Partially Dependent ____

8. Schooling	Name of School	Check No. of Years Attended	Did You Graduate?	Year
Grammar or Junior High		5 6 7 8 9		
High or Preparatory		1 2 3 4		
College or Technical		1 2 3 4 Grad. Sch'ls		

Special Study	Name of Institution	What Subjects Did You Study?	Did You Finish Course?
Correspondence			
Night School			
Business College			
Others			

9. What Languages Do You Speak? _____

10. Give full account of all your time since leaving school, whether employed or not. List separately each position held, whether with same company or not.

From Month	From Year	To Month	To Year	Nature of Your Work	Place Where Employed or Located	Company by Whom Employed

FIG. 50. APPLICATION FOR SELLING POSITION—OBVERSE

11. Give your reasons for leaving your last three positions.

Position	Reasons for Leaving
Last Position	
Preceding Position	
Preceding Position	

12. Shall we communicate with your present and previous employers?

13. Name social and business organizations to which you beloog

14. What forms of recreation do you enjoy?

15. Have you any physical infirmity? If so, what?

16. How much time have you lost through illness during past two years?

17. Are you willing to have a thorough physical examination at our expense?

18. Are you free to go to any part of the United States? Canada?

19. Can you furnish a Fidelity Bond, if required, and at our expense?

20. Have you ever before applied for a position with this Company?

If so, when where

To whom

21. Are you a citizen of the United States? If not, of what country?

Signature

FIG. 51. APPLICATION FOR SELLING POSITION—REVERSE

the company concerned and must describe the job of selling that company's products. The interview schedule and number of interviews are subject to variation to suit the special circumstances of each case.

Hiring may be done at the home office or in the regional sales office. General practice seems to be swinging toward the latter, with the technique of the actual interviewing and judging established by the home office.

3. *Training salesmen.* Perhaps no subject in this general field has received more attention than the training of salesmen. In the past few years many magazine articles and books have been written on it. It has also been a favorite subject in sales conventions and in the programs of various sales management organizations. The core of the problem is found in three questions:

a. Who is to be responsible for the training?

b. Shall it be done at the home office or on the job?

c. Shall it cover both experienced and inexperienced men?

In practice, responsibility for training is found both as a separate function and as a part of the job of the line executive. A tendency seems to be developing for the line executive to be responsible for carrying out the training, but for the methods to be determined by a functional specialist.

The higher education of experienced men has not received the attention that the training of new men has received; and training on the job, while attacked by various methods, such as flying squadrons of trainers, manuals, district office classes and district office meetings, has not been as carefully worked out as centralized training classes at home offices. There is a real need for careful research here.

Partly as a process of selection and partly as advance training, it is sometimes the practice to give salesmen's training courses to persons in the company who are not salesmen but who have indicated a desire to become salesmen. Where there is no position immediately available for the people who complete these courses, such training is of doubtful value. If the person taking the course stays with the company, his interest in some other job has been stirred up at the expense of his performance on his present job. It is more than likely, moreover, he will leave to take a position with another company where a sales opportunity is immediately available. In a recent instance of this sort, out of the group taking the training, two-thirds left the employ of the company when a selling position with the company giving the training was not at once available.

4. *Compensation of Salesmen.* Payment plans for salesmen fall into two main categories—payment based on a time unit, and payment based on results in sales or other criteria. These categories are not

mutually exclusive. Each may stand alone or be used in any combination one with the other.

The system of payments under the first category is, of course, the straight salary. Some of the better known systems of payment under the second category are:

a. Straight commission with drawing account or without drawing account.

b. Salary and commission.

c. Salary and bonus based upon attaining a sales quota, an expense quota, the profit margin on individual sales or on gross sales for a fixed period.

d. The point system based on a weighted combination of such factors as total sales, profit on sales, cost of getting sales, number of items sold, accounts sold (either new accounts or re-orders), lost orders, special requests for service or for prices.

The advantages and disadvantages of each type of payment may be summarized as follows:

Payment by Time Unit

(1) Advantages:

Lessens strain on man due to assured income.

Strong control over salesmen's activities is assured. Detailed daily reports may be insisted upon. Work other than straight selling may be asked for, such as getting credit information, making demonstrations, attending conferences, etc. Salesmen may be shifted from territory to territory without strong objection. Territories may be reduced or enlarged, as warranted. All desirable prospects or customers may be canvassed.

Facilitates the making of budgets.

There is less temptation to overload dealers and jobbers, or use misstatements to get orders.

(2) Disadvantages:

Lacks strong direct incentive to push sales or use initiative.

Encourages the giving of alibis for not selling.

Salary increases are hard to gauge rightly.

May keep out of the organization the aggressive type of man with plenty of faith in himself.

Payment by Results

(1) Advantages:

Presents powerful incentive to increase sales.

Interests aggressive type of man with plenty of faith in himself.

(2) Disadvantages (strongest on the straight commission plan, but applicable to all payment-by-results plans in greater or less degree):

Management exercises only limited control over salesmen, who are careless about reports and play fast and loose with company policies. Hot arguments occur over attempts to shift salesmen from one territory to another or to make changes in territory lines. No time is allowed for tasks other than straight selling, such as advance "missionary" work. There is a tendency to cover only large towns and large customers. Salesmen are tempted to knock off for a few days after they have made a few extra large sales. They feel they are not subject to supervision so long as their sales are good.

Salesmen are subjected to various temptations such as the overloading of customers, splitting of commission with customers, taking on side lines, accepting orders from poor credit customers.

Injustices occur where large sales are made or lost more from other causes than from salesman's influence.

Discontent arises among executives with fixed salaries since the commission salesman may get a greater income than do the executives under whom he works.

The selection of salesmen is affected in that the employer may not exercise much care in selection since the salesmen are "paid for what they produce." Plan attracts the man who is interested in the business only to the extent of his money return from it.

The fundamental difficulty so far in all payment-by-results plans has been the fact that rates have been set before a sufficiently detailed knowledge of the job has been gained. Commissions, for example, have customarily been percentages on the prices of goods. In the early days when salesmen made the prices, this was somewhat more logical, but even then it admitted too little consideration for good-will and the future. As standard prices became the rule, however, commissions as a percentage on price became thoroughly inappropriate. The success of any task-and-bonus plan depends pretty much on how the task is set. So far the variables in the job of selling are so numerous and so little is known about them that a setting of other than an arbitrary task has been all but impossible.

General profit sharing is a form of extra remuneration which seems particularly adaptable to salesmen. It is true that individual reward and individual effort are not closely associated in profit sharing, and it is also true that the reward is not immediate. But many of the fruits of good selling are not immediate, and they are not solely related to the individual effort of the salesman but as well to the support the company gives in goods and service.

General profit sharing for salesmen has been summarized as follows:[1]

Perhaps the most valuable consequence of sharing company profits with salesmen is the development of a sense of partnership with the concern. The value of this feeling cannot be measured definitely in terms of dollars and cents, but it may manifest itself in many ways and on numerous occasions. It may express itself in increased interest in the business, in an attitude of greater loyalty to the house when meeting customers, in a greater effort to sustain pleasant relations between the customers and the company and in a tendency toward a greater permanency of service among the salesmen. The salesman who shares in the profits of the house is more likely to utilize opportunities for advancing the interests of the house, to observe openings for new sales campaigns, to impart to the management or to other salesmen new selling points. He is likely to think of himself as a real partner, and he is placed in a position where that feeling is likely to count to a very great degree. In many concerns the salesman is the only representative of the business who comes into personal contact with the customers, and if he can be inspired with a sense of mutuality of interest and responsibility, the people with whom he deals quickly feel it and accept his attitude as that of the house behind him.

The good-will account of a business house which has a large established patronage is a real asset, and its maintenance depends in large measure upon the relation and attitude of the salesmen toward the customers. When a salesman receives part of his compensation on the basis of company profits, his viewpoint and attitude toward customer are naturally different from that of the salesman receiving commissions or shares of profits based on his individual sales. This difference may express itself in furnishing information to customers, adjusting their complaints, establishing cordial personal relations and endeavoring to build up a permanent buying clientele.

The system of payment employed may be judged by the following criteria: the type of salesmen it attracts; the type of qualities it cultivates in the salesmen; the sales volume that it yields; the balanced selling that it yields, as to profitable and less profitable items, hard-selling and easy-selling items, number of items in a long line, number and type of accounts, missionary work and service to customers; the way in which it affects selling expense, and the simplicity of its administration.

Sales Promotion. Selling is done in four ways: by direct personal contact through traveling representatives, by mail, by advertising and by retail stores.

The first task of sales planning is to seek the best emphasis among these four general classes of activity. Some of the elements to consider are:

[1] James, Gorton; Dennison, Henry S.; Gay, Edwin F.; Kendall, Henry P., and Burritt, Arthur, *Profit Sharing and Stock Ownership for Employees*, New York, Harper & Brothers, 1926.

With traveling representatives contacts are wide and complete, they can be under control and the field can be selected.

Contacts by mail lose over the personal call in promptness, appropriateness of reply, and the influences of the voice, manner, appearance, that are part of personal selling. Mail contacts are under control and the field can be selected.

Contacts by advertising are very numerous. They are extensive rather than intensive. Furthermore, they cannot affect stocks or displays or bring back information as can contacts of the directly personal sort. Advertising is a supplementary activity, therefore, but no one can doubt that it is an important one.

Retail contacts are personal contacts—when they happen. Their extent and the times at which they happen are, however, subject to slight control. They do offer a real opportunity for education in any particular merchandise. Retail contacts are intensive not extensive selling, and are expensive in operation.

Usually sales promotion confines itself to the second and third methods of selling, though when retailing is carried on as auxiliary to general selling it may be included also. Sales promotion should always be sure that its work is so closely tied in to all sales activities as to be a part of them. Especially where selling is to be done both by mail and in person, the two must be run so closely together as to supplement each other.

1. *Selling by Mail.* Selling direct by mail gives to the vender a chance to select and concentrate upon his market and to establish a partial contact with actual and prospective customers. For a given amount of money he can put his case before more people than can be done by salesmen and before fewer people than by advertising. Some fields which are too expensive to cover by salesmen, offer opportunities for mail selling.

The goods which can be sold by mail must be describable by words, pictures or practical samples sufficiently well to make possible an intelligent choice. In this way it is possible to reach remote consumer markets with a broad line of utilities, or to sell supplies to small merchants and manufacturers.

An effective use of the mails can be made by cooperating so closely with road salesmen that the bigger leads, established by mail, can be given them for closing.

2. *Advertising.* How much to spend for advertising is sometimes determined as a percentage of sales. This method, however convenient, is an avoidance rather than a true settlement of the problem. The advertising department approaches its task wrong end to when it starts with a fund and then decides how to spend it. It should,

exactly like the selling department, see the possible measures it can employ and estimate which among them are most profitable. And because wastes in advertising are very likely to escape detection, careful schemes must be devised to check the value of each measure.

If the amount spent for advertising is settled as a per cent of sales, the extent of advertising will increase when sales increase and diminish as they diminish. In many cases this would be wrong. A great deal of discussion has been given to the question whether it is advantageous to advertise most heavily at the top of the cycle or at the bottom. To stimulate sales in a rising market gives a chance to take extra profits when profits are running well. But on the other hand there are great values in getting sales which will help carry overhead charges in slack times; and to regularize production, and insure long-time steady profit taking, it is better to put the heavier stimulation into a market that is not so active; in other words, to do one's shouting when competitors are not shouting very loudly or not shouting at all.[1]

Figure 52 shows advertising appropriations of the Dennison Manufacturing Company over a period of years. This company has followed the practice of advertising most heavily when sales are not coming easily. The program has been laid out over five-year periods and in reference to the best estimate that can be made of probable business conditions. During easy markets advertising appropriations are accumulated to be thrown heavily into stringent markets.

Most merchandise is seasonal to some degree at least, and so the particular time within a year when it is most heavily advertised will usually correspond with the season.

In placing advertising, there is a choice between large space in a comparatively small number of media with large circulation figures, or small space in a comparatively large number of media which individually do not carry large circulation figures. With a mass market to sell, with a production capacity capable of covering the country nationally, with consumers' goods, such as food, clothing or shelter, and with these goods commanding fairly high prices,[2] it is probable that large-space advertising is justifiable.

[1] Since 1921 magazine advertising in the United States had grown each year until December, 1927, when it began to fall off, and it has declined each month since. In January, 1928, the recession was 11 per cent, in February, 9 per cent. Newspaper advertising in the late months of 1927 showed sharp losses for the first time since 1921. It is interesting that newspapers are now (1929) widely advertising newspaper advertising.

[2] A recent survey shows that real conscious activity toward advertised goods does not start until an income level of between $3,000 and $4,000 is reached. (Dr. F. R. Cawl, before Boston Chapter of the American Association Advertising Agencies, May 22, 1928.)

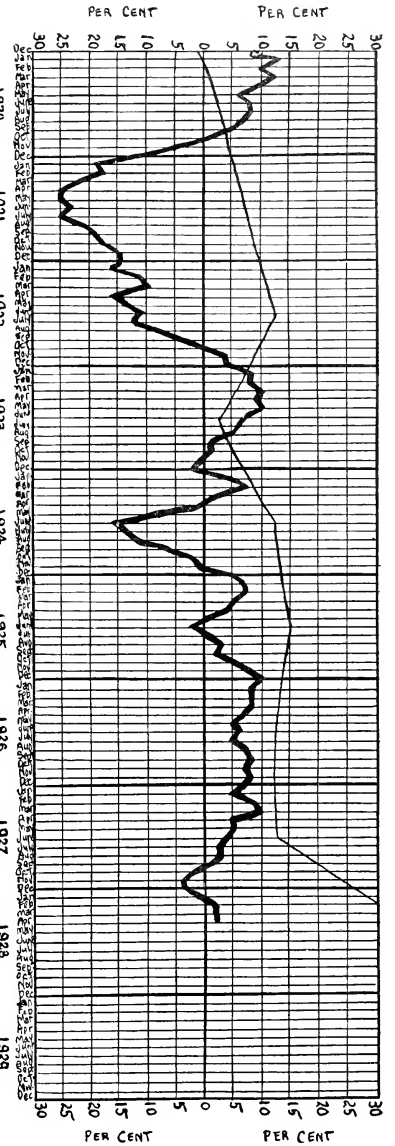

FIG. 52. A POLICY OF ADVERTISING TO OVERCOME SALES RESISTANCE

The proponents of large-space advertising say that:

A full-page advertisement is actually seen by more people; a full page carries prestige to dealers and salesmen, and is a good talking point with them; it offers opportunity for more copy, striking layouts, better type and better illustrations, and it secures more favorable position in magazines and consequently it is more probable to attract the readers' attention.

The proponents of small-space advertising say that:

It can be placed so that it is adjacent to news columns and therefore may more readily come to the attention of the readers; because the cost per unit of space is small, insertions can be taken in a publication more often; the continual repetition of small advertisements can make more of an impression than spasmodic advertisements in larger space; it is easier to center attention upon one product or one feature of a product in small space; in larger space where cost is higher, there is the necessity or the temptation to scatter interest by including information about a whole line of products or by mention of too many features of a particular product; it is often easier to read an advertisement in smaller space; by placing advertising in small space in a large number of publications rather than large space in a few publications, copy can be changed so that the appeal will be more particularly to the class or the group reached by the individual magazine.

The method in any particular case once chosen must be thereafter tested by the results obtained. A method of checking these results should constantly be employed. With some types of merchandise, the return may show the higher cost of large space to be justified. After testing many sizes, the Dennison Manufacturing Company's experience for its merchandise indicates that the best results are obtained from seventy-line, quarter-page, single-column spaces, employed in a large number and variety of publications; and by advertising one product or one use for a product at a time.

The more prominent forms of advertising media follow.

The most common media of printed advertising are newspapers and magazines. The former make possible a close regard for local conditions in the preparation of the advertisements. Newspaper advertising often enables a tie-up between the activities of the dealer and the advertiser, and when coordinated with the introduction of a new product, or a special drive on a product in retail stores, can often bring immediate results locally.

Magazine advertising gives national coverage quickly and at a comparatively low cost. The life of the magazine is longer on the average

than that of the newspaper, and consequently the advertisement is more likely to be read. To get direct inquiries, magazines are more effective than newspapers. Magazine advertising does not often establish a product as quickly as does newspaper advertising, but it is likely to give more prestige and permanence to a product.

Dealer helps include such things as window-display cards, newspaper electros and lantern slides, as well as envelope enclosures and circulars for dealers to use for store distribution. Many advertisers obtain a more careful use of selling helps furnished to dealers by charging a small amount for them. The Dennison Manufacturing Company has sold to dealers thousands of booklets giving instructions in the use of Dennison goods. The dealer has resold the booklets to his customers at a small profit.

Radio advertising up to the present time has been used chiefly to obtain good-will for a product. It is primarily "name" advertising. Most experiments by department stores to use the radio as a direct sales medium have been discontinued, for the time being at any rate.

Exhibits at local fairs or shows attended by the home consumer sometimes offer an opportunity to demonstrate goods or uses of products to people difficult to reach in any other way. The possibility of using exhibits at such fairs, however, is extremely limited. Exhibits at business shows and conventions offer limited possibilities, also, but they too often tend to become a part of a professional promotion plan or to be used merely to defray the cost of a trade convention.

The public is so used to the million-dollar productions from Hollywood that an industrial picture produced for an advertiser suffers very often by comparison. It is difficult, also, to obtain showings for an industrial film where it will be viewed under the right conditions by home consumer prospects. A film for use in a portable projector by salesmen in selling business consumers is often of considerable value. There are special distribution difficulties to be overcome before motion pictures can become media of major importance.

Billboards and posters are often good media for cultivation of local markets, especially when tied up with other forms of advertising. They are most profitable for low-priced merchandise for which nearly every one is a prospect every day. Chewing gum and gasoline are good examples. Billboards and posters are profitable also for the advertising of merchandise of high-unit value, such as automobiles and electric refrigerators. Billboards serve largely as "reminder advertising."

By means of a coupon or through an announcement in magazine advertisements, advertisers are able to place in the hands of prospective consumers, booklets and circulars which encourage the purchase of

products by giving directions or suggestions for use.[1] Questionnaires have proved that people who have purchased a booklet by mail have bought merchandise from local dealers in a high percentage of cases as the result of the information given in the booklets concerning the uses of the merchandise.

A circular leaflet inserted in the carton containing one product offers the advertiser an opportunity to tell the purchaser about other products offered by the advertiser.

Every advertisement costs money; it either brings that money back with a profit or it does not. Advertising is an expense only when it is a gamble. It can become an investment when backed by common sense, time and constant measurement of results.

An advertiser before appropriating a large amount to advertise a new product or to advertise an old product in a new way, should first of all prove that the new advertising will be a good investment by testing it carefully in a small way. The best way is probably to try for inquiries by offering in the advertisement a free trial sample of the product or a booklet explaining its uses. The advertiser can then determine the interest of the public in his particular product, and the best possible way to arouse that interest if it exists. He can likewise measure the comparative interest of different classes by testing publications in different fields—rural and urban.

When a tested type of advertising proves that it is profitable, the advertiser can proceed on as large a scale as conditions warrant. When once advertising is started, it should be kept going. It cannot be turned on and off like an electric light over long periods and still be profitable advertising.

3. *Demonstrations.* By actual demonstration of a product's uses at the point of sale, sales of certain products can be greatly stimulated. For an example we have only to look to the street hawker who can quickly exchange many bottles of "snake oil liniment" for hard-earned half dollars simply by a quick demonstration accompanied by a good rapid-fire line of verbal patter.

The same principle in more conscientious application can be applied to standard advertised merchandise sold through established channels. Some goods, such as automobiles and their accessories, whose uses are known, must nevertheless be demonstrated in order to be most effectively sold. The sale of agricultural machinery has been materially helped by "agricultural chautauquas." There are other goods, however, whose uses are unknown or known only in part, which practically depend upon demonstrations to find their full market. Such among

[1] The company with which the authors are associated has since 1922 sold by magazine advertising hundreds of thousands of instruction booklets at ten cents per copy.

many others are electrical appliances, some package foods and craft articles, such as crepe paper, raffia and sealing wax.

Many advertisers not only have their own traveling demonstrators, but train dealers or dealers' sales people so that demonstration can be carried on almost continually through instruction departments established in their stores.

4. *Dealer Cooperation.* The advertiser who gets the best cooperation from dealers is the one who cooperates with them best. Too often an advertiser bends all his efforts toward the creation of a consumer demand, assuming that dealers will stock and push his product because of this demand created by mass advertising.

For products with quick turnover possibilities, such an assumption may not be far wrong; but for specialty merchandise which is more of a luxury than a necessity, service is necessary to obtain full dealer cooperation. This service can take many forms, such as demonstrations, traveling exhibits, booklets, dealer magazines, to give him such aids as sales information, newspaper electros and window displays.

Whatever the service, it should be most carefully planned and executed. It should be created with the idea of the dealer's need uppermost in mind. When the advertiser's cooperation is right, there is little need to worry about the dealer's cooperation.

5. *Cooperation with the Sales Force.* Wise salesmen will "sell" the company's advertising and sales promotion plans to dealers just as they sell merchandise. If they can prove to dealers that their company is creating a consumer demand and is willing to give dealers full cooperation, the dealers in turn will be enthusiastic and will cooperate. It behooves the advertiser, therefore, to give his salesmen not only complete information about his advertising and sales promotion plans, but to give it in a form which the salesmen will understand and can use in passing on the word to dealers.

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CHAPTER XXI

CONTROL OF OFFICE OPERATIONS[1]

THIS chapter will treat briefly of some of the major problems concerning the planning, direction, and control of office operations as a logical development of research and standardization presented in other chapters.[2]

Office Organization. During recent years increase in the size of offices has made possible the application of the principle of specialization. Major operations which are handled in large volumes are split up into relatively simple units, and wherever possible duties of a similar nature are centralized. A large accounting department might be functionally divided into as many as ten or more units, such as accounts receivable, accounts payable, cashiers, notes receivable, notes payable, credits and collection.

What might be termed office-service functions can be effectively centralized in such groups as a central stenographic and transcribing bureau, central filing, mail section, stationery and supplies, and messenger service.

This tendency toward centralization and specialization promotes utilization of the principles of scientific management. It makes for a higher degree of efficiency, both as to quantity and quality of clerical production. New clerks are more quickly trained where the tasks are highly specialized. This is a particularly important feature in office organization work where female help, with its large normal turnover, predominates. Specialization also makes possible effective scientific planning and scheduling of the work.

It has been only within recent years, and then but to a limited extent, that the principle of line and staff functionalization has been applied to office operations. The position of office manager or planning manager, as a staff function, is gradually attaining the same importance in the office that the function of the industrial engineer holds in the factory. The office manager is presumably a specialist and should be better qualified to direct clerical activities which are common to all operating departments, such as clerical personnel management, selection of equipment, scheduling of production, than the operating department head.

[1] By F. L. Rowland, Manager of Office Administration, Lincoln National Life Insurance Company, Fort Wayne, Ind.

[2] Cf. Chapter VI and Chapter XIV.

One large American insurance company has definitely set forth the specialized function of their clerical department managers as follows: (1) to direct the routine flow of work through the department as economically as possible and with dispatch; (2) to deal with emergencies that come up and render decisions on unusual and exceptional transactions; (3) to develop the technique of the work under their supervision.

All other functions having to do with the operation and management of the office are under the direction of the office manager cooperating closely with the operating department heads.

Office Personnel. 1. *Employing.* Intelligent employment of office workers presupposes a familiarity with the different types of clerical work. Job qualifications gained from analysis and experience are predetermined for the several classes of office positions. This information is usually accumulated through what is commonly known as the job analysis. It is a complete description of the detailed duties of particular clerical occupations containing sufficient information to set up standards. From this information all jobs are classified according to a predetermined schedule. The classification presented below is with minor changes adaptable to most offices:

Group I—Executive and Expert

This group is determined by special standards. It includes the assistant secretaries, advertising manager, chief accountant, traffic manager, and major department heads.

Group II—Special and Supervisory

This group includes positions involving:

Supervision of routine or clerical work where a department is large enough for supervision to be an important feature.

Work on special varied assignments.

Work requiring training or experience of an unusual nature.

Work involving unusual responsibilities.

It includes the production supervisors, cashier, executive assistants, technical assistants, etc.

Group III—Senior Clerical

This group includes positions of responsibility involving:

Expert knowledge of bookkeeping, accounting, etc.

Supervision of junior clerks.

Expert stenography and secretarial experience.

It would include experienced secretarial assistants, bookkeepers, etc.

Group IV–A—Junior Clerical

This group includes experienced clerks, experienced stenographers and skilled office machine operators.

Group IV–B—Junior Clerical

This group includes positions of a semi-skilled nature such as file clerks, general clerks, typists, inexperienced stenographers and addressograph operators.

Group V—Novice Clerical

This group includes positions of a routine nature such as messengers, mimeograph operators, sorting clerks.

Having the qualifications for the position to be filled, the personnel director makes a selection from the available applicants. He is aided in this selection by the use of various types of tests which aim to reveal mental capacities and technical proficiencies in relation to the particular type of work for which the applicant is to be engaged.

In most offices employing fifty or more clerical workers, applicants for positions are required to pass a physical examination. Applicants with such physical impairments as poor eyesight, goiter, heart, lung or other organic weaknesses are usually considered undesirable for office work. Some companies reject as many as 20 per cent of applicants on account of health impairments.

Educational qualifications are considered among the most important factors in judging applicants for clerical positions. Graduation from a high school or its equivalent is rapidly becoming a criterion for most office positions. Such organizations as banks, insurance companies and publishing houses require high-grade office workers and give preference to those applicants who have attained high grades in their academic work.

2. *Training.* The training program for office workers in well-organized institutions is divided into three parts: the vestibule school, job instruction and company classes.

a. The vestibule school, as the name implies, offers instruction before the employee is assigned to a definite desk. Class work in a vestibule school may extend from one week to three months. Under the direction of a competent instructor, apprentice employees are trained in the type of work to which they will be eventually assigned.

b. Job instruction usually takes the form of verbal instructions given by the department manager or one assigned to this work, supplemented by written job manuals.

c. Job training is frequently accompanied by class work in the more technical and broader features of the business. This type of training work aims to give the employee a broader grasp of the business and to prepare him for advancement.

3. *Wage Payments.* The principles of rational salary administration apply with minor qualifications to all offices regardless of size. They may be briefly stated as follows:

a. There should be approximate uniformity in remuneration for the same grade of work throughout the organization.

b. A logical relation should be maintained between different grades of work and the respective remunerations for them.

c. Office jobs can be graded (or classified) into levels or zones according to the degrees of difficulty and responsibility.

d. There is a lower limit of remuneration for each job below which compensation would be unjust and unethical.

e. There is an upper limit of remuneration for each job above which compensation would be uneconomical regardless of how well the work was performed.

f. There should be an opportunity for regular progression from the lower to the upper limit of remuneration for a job.

g. The efficiency and individuality of the worker should determine his position between these limits.

h. There should be an opportunity for promotion to positions of higher grade at increased salaries.

Unfortunately, the great majority of office tasks do not readily lend themselves to individual measured production control. However, a well-developed plan of salary standardization based upon job analysis and equitable grouping, and supplemented by periodic reports of attendance, deportment, application to work and suggestions, provides a basis for an equitable plan of salary administration.

A maximum and minimum salary is established for each group based upon the going rate in the community for similar types of work and the relation which the particular types of work might bear to other job classifications in the particular office in question. Salary advancement is made within the group maximum, adjustments being determined by individual efficiency and general aptitude and attitude in the work assigned. When employees attain the maximum for a particular group, they become eligible for transfer into a classification carrying a higher maximum salary.

The judgment of the department head or immediate superior of an employee should not alone be the determining factor in making salary adjustments. The recommendation of the department head should be supported by periodic reports of performance which should be supple-

mented by the judgment of the personnel director. The question of compensation basis of production will be treated later in this chapter.

4. *Supervision.* The supervision of clerical workers calls for the same elements of leadership as is demanded in other successful types of organized effort. Only too often supervisors and department heads are selected because of age and technical knowledge, with lesser concern for the factor of leadership. The ability intelligently to train and direct the effort of clerical workers is a major qualification of an office supervisor.

The essentials of maintaining a high morale in an office force comprehend uniformity of working conditions with a uniform observance of office rules and a standard salary scale. Most offices today have fairly uniform working conditions and the tendency is toward a scientific determination of wages based upon job classifications. The enforcement of office rules uniformly and without partiality is a problem of major importance in office administration. This is particularly true of large offices where supervising authority is delegated to many department heads.

The "Office Manual" or "Office Rules," as it is sometimes called, is an essential tool in the administration of office supervision and discipline. It permits employees to become familiar with the essential office policies and other standards. It relieves the department head of the task of outlining the office rules and regulations to each new employee, and it places the responsibility of observing them upon the clerk. It also provides a basis of uniform treatment for office workers throughout the entire office organization.

Below is an introduction to an office manual prepared for the office force of a large American insurance company:

Introduction

This manual has been written to give Home Office employees of the Lincoln National Life Insurance Company a general knowledge of the established policies and accepted practices of this Company. It will also provide a convenient and accurate guide by which new employees, engaged in clerical activities of all kinds, may familiarize themselves with our methods and policies, as well as to become acquainted with the office rules and regulations in order that they may enter into the spirit which prevails throughout this organization, and conduct their work in accordance with our ideals and standards. It is our desire to maintain a harmonious, smoothly functioning organization, free from misunderstandings and prolonged differences of opinion. In order to attain this end it is necessary that all our Home Office employees study the organization, its policies, rules and regulations from the same point of view.

It is vital to the successful operation of our business that the policies set forth in this manual be observed. In the main they consist of policies, rules and regulations which have been in force for several years. We have endeavored to eliminate anything which savors of arbitrary rulings, or which

infringes upon personal liberties of our employees. The contents of this manual may be changed from time to time as better thoughts occur. We welcome suggestions for improvements which are consistent with the ideals of the Company and which make for a better functioning organization. However, until such changes are authorized, it is to be expected that all our employees observe in spirit as well as in practice the contents of this manual.

We expect the Company's policies as set forth in this manual will give to new employees the essential principles upon which our clerical activities are based, without requiring the time of another to explain in detail. We expect also that it will save the Department Manager considerable time and will avoid the annoyance of reiterating decisions on common points.

Some of the subjects generally treated in an office manual are:

Absence from office
Care of company equipment
Care of office records
Change of address
Courtesy
Desk efficiency
Destruction of office records
Discussion of Company business
Grievances
History of the Company
Holidays
Interviews
Notice of resignation
Office employees' conduct
Office hours
Office organization
Overtime
Payment of Salaries
Personal mail and express shipments
Personal visitors
Smoking
Subscriptions—flowers, presents, etc.
Tardiness
Telephone and telegraph service
Time signals
Turning off lights
Vacations

Control of Output. More important than any other factor in effecting economical office production is a proper coordination and control of work. A well-developed plan of control should meet three requirements: it should provide prompt information concerning the volume of work to do, the force available to do it, progress of work, and units completed; it must be sufficiently flexible to permit the shifting of workers to follow the peak load; and it should provide a basis for appraisal of the relative contributions of workers engaged, and for compensation. (See Figures 53 and 54.)

Unfortunately the precise plans of production control [1] which may be developed in the factory are not so readily developed in the average office. In the office a larger number of variables are always present. Clerical work should have the following characteristics in order to permit the application of the factory plan of production control: (1) it must be in volume and divisible into highly specialized units, each consisting of relatively few repeating operations; (2) in general, the work should be of a mechanical or at least of a mental-mechanical nature as contrasted with clerical work of which the output is de-

[1] Cf. Chapter XXII.

pendent largely upon pure mental processes; (3) there must be continuity of work; intermittent work with a widely fluctuating volume should not be considered in a practical task-work scheme; (4) the work must lend itself readily to simple controls for accuracy; (5) the unit of production must be readily measurable; where elaborate controls are necessary for measuring production and maintaining time records, the basic purpose of the plan is likely to be defeated.

It is evident that these limitations eliminate many office operations from the methods of precise planning and control. Outside a limited field, the office manager is likely to become lost in a maze of variables, and find that the cost of keeping the records necessary for control exceeds any possible value which may come out of it. But in large

Severity of Sick Absence.—Working Days Lost per Clerk-year by Sex and Age, 1—All absences, 2—Excluding absences of 1 day, 3—Excluding absences of one and two days and ratio of female to male rate.

Age Group	Days lost per clerk-year Male			Days lost per clerk-year Female			Percent Female of Male Rate		
	All Absences	Excluding 1 day	Excluding 1 and 2 day	All Absences	Excluding 1 day	Excluding 1 and 2 day	All Absences	Excluding 1 day	Excluding 1 and 2 day
All ages	8.82	8.10	7.77	12.44	10.61	9.82	141.0	130.9	126.3
Under 20	8.44	7.23	6.71	8.60	6.67	5.96	101.9	92.2	88.8
20 to 24	8.79	7.67	7.34	12.96	10.88	9.88	147.4	141.8	134.6
25 to 29	9.30	8.66	8.27	15.22	13.56	12.68	163.7	156.5	153.3
30 to 34	6.30	5.79	5.48	13.61	12.15	11.46	216.0	209.8	209.1
35 to 44	6.43	6.12	5.87	15.56	14.23	13.49	241.9	232.5	229.8
45 to 54	11.20	10.95	10.79	25.10	24.12	23.27	224.1	220.2	215.6
55 to 64	17.39	17.23	17.06	15.29	14.29	13.95	87.9	82.9	81.7
65 and over	4.09	4.02	3.94	4.20	3.40	2.60	102.7	84.5	65.9

FIG. 53. EXAMPLE OF CLERICAL CONTROL DATA

offices maintaining highly specialized groups of operators with a steady volume of work, it is possible and practical to develop a control plan. The most successful control has been applied to such work as typing, phonographic transcribing, punching tabulating cards, and in some instances to mechanical billing.

The procedure of setting up such a plan follows closely the technique developed in the factory. First a unit must be established as a measure of production and then a standard time set for the job. The stop watch can be used effectively for the setting of standard times.

Several different types of unit are used, according to the nature of the job: for straight typing the "lines typed," either expressed in terms of actual lines (counted) or cyclometer (meter) readings; for dictaphone transcription, the "number of records" transcribed; for tabulating punch-card work, the "number of cards punched." In accu-

mulating production records in terms of such units, errors must be considered as minus values.

A production bonus may be established and is based upon the ratio of actual production to the predetermined standard. The incentive

105-B Bookkeeping Division

Divisional Index of Production: Policies in force at beginning of period plus new issues plus terminations

	Number of Employees	Divisional Index of Production	Salary Cost	Divisional Index of Cost (.o dropped)
January	17¾	126,533	$1,460.75	.1154
February	14¾	127,437	1,326.00	.1040
March	15¾	128,739	1,351.25	.1049
April	14¾	129,680	1,390.75	.1072
May	14¾	131,540	1,253.00	.09525
June	14¾	132,097	1,318.50	.09981
July	13¾	133,759	1,285.75	.09612
August	13¾	133,769	1,293.75	.09671
September	13¾	133,824	1,308.75	.09707
October	13¾	136,733	1,313.75	.09608
November	13¾	137,628	1,303.75	.09471
December	13¾	139,110	1,313.75	.09443
Average Last quarter	13¾	137,823	1,310.42	.09507

Divisions	Average Index Jan. Feb. & Mar.	Average Index Oct. Nov. & Dec.	% of Increase Last Three over First Three Mos.	% of Increase Last Three over First Three Mos.
General	.18	.18		3.27
Accounts Payable	15.05	16.08	6.84	
Addressograph	.43	.39		9.46
Agents Accounts'	.10	.13	25.27	
Bookkeeping	.11	.10		12.12
Cashier	.70	.65		6.88
Filing (Accounting)	.38	.35		8.18
First Year	41.70	36.55		12.35
Loan	54.59	40.34		26.10
Notice	.31	.28		6.65
Renewal	.15	.13		11.56

FIG. 54. EXAMPLE OF CLERICAL CONTROL DATA

which a bonus plan provides generally results in a saving to the employer and additional earnings to the employees.

The major problem of clerical production control lies in the field of office work which is not readily adaptable to exact unit measurement.

This has led to the development of a plan for clerical production control for the major portion of clerical work which retains many of the advantages of the factory method. It can be safely said that 90 per cent of the clerical jobs in the average office can be placed under a form of control where production can be expressed in terms of units.

Practically every office operation of a repetitive nature bears a relation to some major unit of the business. The production of a considerable number of clerical jobs varies directly with the number of orders received. Other office tasks vary with the number of items produced in the factory, or with the number of items shipped.

The measurement and control of clerical production in terms of such units is known as the "work-unit" plan. The object of the work-unit plan is to obtain an index of the volume of clerical production periodically, and to obtain the cost of clerical production expressed in terms of some representative unit.

A work-unit may be defined as an index by which one is able to measure or express the volume of clerical production in the group to which the index is applied. The first step in the procedure for installing the plan is to determine a practical index, or work unit, which will equitably reflect the clerical production for the group concerned. It does not comprehend the measurement or control of production of individual clerks; it is applicable only to homogeneous groups.

In the majority of cases this index will not be a highly scientific one in the sense that it is based upon a detailed job analysis of all operations performed in the department. Rather, it might be said to be a practical index which reflects in a general way the relative output. For instance, the unit "number of checks written" may possibly be considered as an equitable index for a cashier's section or an accounts-payable division. Even if the clerks in these sections perform numerous other duties, this unit from month to month will reflect the relative volume of work performed. As a rule other miscellaneous duties will fluctuate with the unit selected. Other units which are sometimes used for different departments are "number of invoices written," "number of letters received and answered," "number of tabulating cards punched," "pounds of mail received and sent out," and where general departments are concerned, "volume of sales or shipments" expressed either in physical or monetary terms. It is important to note that all the units recommended are readily available without undue expenditure of time or effort. In the majority of instances they are compiled for other uses.

Once this first step has become fully developed and effectively used, one can safely take up the determination of standards on individual clerical operations.

The next step in the procedure is to establish a classification of office-operating accounts which will readily permit the grouping of all controllable costs departmentally. The largest item of controllable cost in office work is, of course, salaries; among other items are telegraph, telephone, stationery, office supplies and overtime. It has been found advisable to eliminate in such reports items of expense which are practically uncontrollable in so far as the department head is concerned—such items as heat, light, floor space, rental and janitor service. Regardless of the general accounting view of these items, a supervisor of work considers them as practically uncontrollable in so far as he is concerned; to report them tends only to obscure the real controllable figures on the operating report.

With a periodic report of the units produced for the different clerical groups and the clerical cost of producing these units, we have a basis for determining the cost of clerical production and the essentials of what a production-control plan should provide. It is not essential for control purposes that we be concerned about the actual dollar-and-cents cost of a unit production; rather, the important feature is the percentage of increase and decrease in cost by group from month to month or year to year.

One of the outstanding benefits to be derived from a control plan such as has been suggested, is to be found in the incentive it provides department heads to maintain an equitable ratio between production and cost of production (always with due consideration for quality). When a department head realizes that his value to the organization is dependent to a considerable extent upon maintaining a low unit cost of clerical production for his clerical group, he immediately becomes a positive factor in any program aiming toward economy in clerical operations. Moreover, his attitude is reflected throughout the organization over which he presides.

The plan of combining the work-unit method of control of clerical production with the group bonus has been successfully carried out by a few office organizations. Through the medium of a job analysis, a standard is set for each group expressed in terms of production indexes. When the production-cost index is reduced beyond a fixed point, a bonus is paid each member of the group, usually on a monthly basis. The bonus is distributed on the basis of the amount of salary received by each worker under the assumption that the salary reflects the relative contribution of the workers. The department head participates on the same basis as the clerks.

The amount of bonus distributed to the group represents roughly an even division between the company and clerical workers of the savings over the predetermined standard. In some cases this standard

merely represents the average-production index over a period of six months or one year immediately preceding introduction of the plan.

There are so many factors that have a bearing upon increasing or decreasing of clerical costs, some of which are entirely beyond the control of the clerical worker, that the fixing of the amount of bonus to be paid must be somewhat arbitrary. It is important to the success of any plan of production control that the worker share with the employer the savings resulting from reduced clerical costs.

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CHAPTER XXII

CONTROL OF SHOP OPERATIONS[1]

Introduction. The control of shop operations or the planning and direction of work, as it may better be identified, comprise three major objectives: (1) predetermining what is to be done, how it is to be done, what facilities and materials are to be employed, and when it is to be done; (2) providing and bringing together at the right time the material, the facilities, the requisite information and the qualified worker; (3) providing such auxiliary assistance, service and supervision as may be essential to the successful and economical accomplishment of the work.

The first of these—the predetermination of what, when and how—starts with the provision of drawings, specifications, models or samples, the object of which is to show, in a manner that will preclude the possibility of error or misunderstanding, the nature of the article to be produced or the service to be performed. In many lines of manufacture, particularly in the metal trades, it has long been the practice to provide mechanical drawings, but it has only been within recent years that there has been an appreciation of the full purpose that drawings should serve and of the information they should convey—in short, of the fact that the main purpose of drawings is to answer every question that might arise as to just what is required.

In the past, and even now too often, the designer or draftsman leaves important details to be decided by the workman or the foreman, such, for example, as the degree of accuracy, the kind of finish required, and so on. Very often too little thought is given by a drafting or engineering department to what equipment is available, the means by which a job is to be held on a machine or the manner in which unnecessary work and possibility of error may be avoided. In the nonengineering industries there is an equal need for some equivalent of the mechanical drawing; this may be filled by models, samples or specifications.

The writer recalls that Taylor, in speaking of machine-shop management, said that much of the planning (of how work should be done) should take place while the work is being designed. And it is astonishing to see what savings in cost and increase in production result when effective cooperation has been brought about between an engineering or designing department and a planning department, with

[1] By H. K. Hathaway, Consulting Engineer, New York, N. Y.

frequent consultations as the work of determining "what is to be done" goes on.

In the procurement of materials, clean-cut and definite specifications avoid trouble and losses to both the buyer and the vendor.

When the basic information as to what is to be done has been provided, the next step is to determine how the work is to be done, what facilities are to be utilized, and what materials will be needed at each stage of the work. This would include what are in most instances of scientific management regarded as two distinct major functions of a properly organized planning department: namely, "routing," [1] and the preparation of detailed instruction cards defining the manner in which individual operations are to be performed. The latter of these two functions, or stages, in the planning of work is in reality a continuation of the first.

These two functions of planning call for the previous establishment of certain features of the Taylor system that are essentially preliminary and auxiliary to the functions in question. Without these, effective planning will be found difficult if not impossible. They are: (1) rearrangement of machinery or such other equipment as may be necessary to facilitate the storage of materials (jobs ahead) at the various machines or work places and its movement from operation to operation, greater independence in the use of machines and of personnel, and so on; (2) the establishment of a store room and a system for its operation or, as today few plants are found totally lacking in this respect, the development or modification of existing store rooms and systems to meet the requirements of routing and of centralized control; (3) development of the order system—including shipping orders and manufacturing orders; (4) development or modification of the balance-of-stores or stock-record system so that it may not only be a record of transactions and of what is on hand in the store rooms, but also a live agency regulating the procurement of materials and feeding work to the shop; (5) provision of suitable information relating to the product to be manufactured, in the shape of drawings or specifications, showing as a basis for routing the materials required and what is to be done; (6) standardization of machinery, tools and other facilities, and the availability in the planning department of codified data in regard thereto.

[1] The term "routing" has taken on a more specific meaning with the evolution of scientific management than the sense in which Taylor used it in his book, *Shop Management*. See articles on this subject published in *Industrial Management*. Vol. LX, October, 1920, pp. 278-286; November, 1920, pp. 353-361; December, 1920, pp. 445-451; Vol. LXI, February, 1921, pp. 126-134; *Industrial Engineering*, Vol. XII, No. 1, July, 1912, p. 7, and Vol. XII, No. 3, September, 1912, p. 97; and *Annals of the American Academy of Social and Political Sciences*, Vol. LXXXV, September, 1919, pp. 231-256.

Each of these functions must be performed by individuals possessing knowledge and experience of a practical character, at least equal to that of the old-type foreman and workman, as well as some clerical ability. They must be able to analyze the work to be done, and to weigh the merits of one method as compared with another. As already suggested, they must cooperate effectively with the department responsible for designing the product, giving that department the benefit of their practical knowledge. At the same time they must not be above conferring with and seeking the advice of shop foremen and others who are to execute the work being planned.

The second phase of planning and control covering the bringing together at the right time of facilities and workers, would include: (1) the work of the balance-of-stores (or stock-ledger) clerk, which has for its object the maintenance of a proper supply—adequate but not excessive—of all materials or parts, whether purchased or manufactured, that should be regularly carried in stock; (2) the procurement of any materials that are not carried in stock and hence must be obtained specially for the work being planned; (3) the order-of-work function which includes the assignment of workers to machines or work places and their transfer as fluctuations in the amount of work ahead of the various machines or work places may necessitate; the scheduling of operations or jobs to be done at each machine or work place in accordance with their relative importance; recording progress on each job and seeing that it moves from operation to operation without undue delay, and last but by no means least in importance, taking whatever steps may be necessary to straighten out the trouble whenever anything does go wrong. This might be called the executive phase of planning. As one client exclaimed, when I described the duties of the production and order-of-work supervisors and pointed out the need of a higher class of personnel for this work, "Why, those men run the shop." And so they do, according to the plans and methods laid out and with the cooperation of the shop functional foremen and other auxiliary services.

The third phase of planning and control, covering auxiliary and supervisory assistance, includes the work of the functional foremen in the shop. (1) The preparation supervisor, who was formerly known as the "gang boss," has to see that preparations are made in advance for the work as scheduled by the planning department; that tools, materials and information are delivered to the machine or work place; that the worker is assisted in finishing one job and in getting started promptly on the next. He is also as a rule held responsible for the cleanliness and orderliness of the section of the shop under his jurisdiction and, in a greater or lesser degree, the disciplinary function

may be delegated to him. In passing, I should like to say that in a plant operating under true "Scientific Management" disciplinary action is rarely called for. (2) The instructor, or shop methods supervisor, was originally designated by Taylor in a machine-shop organization as the "speed boss," because at that time it was his duty—since transferred to the planning department—to determine the cutting speeds and feeds at which machine tools should be run. It is his duty to see that each operation is performed in accordance with the method planned, as shown by the instruction card. This is largely a matter of assisting the worker to an understanding of the method to be followed and of helping him by demonstration, by pointing out where he may be at fault or simply by encouraging him if he has difficulty in attaining the standard production. The instructor naturally devotes much time to teaching new workers. (3) The inspector, or quality supervisor, has to instruct operators in all matters relating to quality and afford them every possible assistance in obtaining and maintaining the standard required. His object is principally to prevent errors rather than to detect them. The latter, however, must not be neglected. (4) The maintenance supervisor (referred to by Taylor as the "repair boss"), the stores-department, the tool-room and move men contribute in an auxiliary way to the control and performance of the work planned.

Under scientific management the functional foremen or supervisors *serve* the workers, rather than *boss* them in the old sense. This does not mean, however, that they are not vested with authority, each in his proper function, but that in a functionalized organization, with duties clearly defined, with work properly planned, and with properly established standards, cooperation supplants bossing and the old master-and-man idea fades out of the picture.

Routing, materials control, instruction cards, and order of work are the major mechanisms of the planning room through which these three objectives of control are achieved.

Routing. Routing consists in analyzing any work to be done so as to determine: (1) the number and kind of component parts entering into the product in question and whether they are to be manufactured specially for the order or drawn from purchased or manufactured stores; (2) the relation of one part to another—or a group of others—with a view to their being brought together as required in the process of manufacturing the product; (3) the kind and quantity of material required from which to make each component part to be manufactured specially for the order and whether such materials are to be drawn from stores or procured especially for the order; (4) the operations which must be performed on each component part of

each assembled unit, the sequence in which such operations must be performed and the machines or work places in or at which the work is to be done; (5) how to subdivide the work into independent operations so as to separate work of a highly skilled nature from that of a simple character which may be performed by relatively unskilled help; (6) to what extent, if at all, the quantity required of each of the parts to be manufactured should be subdivided into batches in order to facilitate manufacture and handling; (7) how to prepare route charts showing the foregoing in diagrammatic form—in the case of a number of components to be manufactured and assembled—and route sheets serving the double purpose of recording progress and indicating and controlling each successive step to be taken in the production of each component part or in the assembling of the parts.

In short, the function of routing consists in analyzing and planning in advance from drawings, specifications or samples, what materials are required and their sources, and what work is to be done, in order to produce the article or result desired.

The intelligent development and use of a routing system requires not only an understanding of its mechanism, but also of the ultimate purpose to be served. Its purposes are: (1) to avoid errors, oversight and delay in providing materials required for the manufacture of the product; (2) to avoid hasty (and often poor) planning, with all the delays and possible errors incident to the practice of putting work into the shop and leaving the planning to be done on the spur of the moment by the foreman or the worker; (3) to provide a means for regulating the flow of work through the plant in an orderly manner and in accordance with requirements instead of in the haphazard manner inevitable in the absence of such a mechanism; (4) to provide the means for recording progress on every job and permitting the ready ascertainment of what has been done and what remains to be done without having recourse to the foreman's memory or requiring that such information be acquired through physical verification, with all the possibility of error involved; (5) to avoid false moves, as in the case of starting assembling operations before all of the necessary materials are ready with the consequent delay and confusion incident to hunting up the missing parts; (6) to provide information at all times as to the amount of work ahead of each machine or other producing unit, avoiding the inevitable delay between jobs which results when the foreman in the shop is required to do all of the planning and assignment of work.

There are, of course, types of manufacture in which the character of the work is so simple, and in which there is so little variety in the product, as to require nothing in the way of a routing mechanism that,

to the average person, seems to have anything in common with the elaborate system required in manufacturing complicated machinery.

The extreme of simplicity in this respect would be a mill turning out a single product, the same throughout the year. In such a case the machinery would be special and suited to a single purpose, or operation, in the process. The number of machines for each operation would be in proportion to the relative time required to perform each operation on a given quantity of the product. Materials would be fed into the manufacturing department at such a rate as to meet the requirements for production, and provision would be made for its movement at a uniform rate from operation to operation. Of course, in such a case there is need of some record of progress, or production, both for the purpose of paying for it, if the work is done under task and bonus or on a piece-work basis, and for accounting purposes; but little more than bookkeeping with the various operations is required. The work is not divided into lots of definite quantity, each covered by a manufacturing order; no route sheets are needed on which to record progress; no operation orders, no move orders, and no inspection orders are issued from the planning department. There must be, however, a definite report of production from each producing unit. This may be a report covering the quantity produced in a given time or a report turned in upon the completion of a given quantity.

We do not have to progress so very far from extreme simplicity of product and of process before we feel the need of more control or regulation in the progress of work. Routing is indispensable as a basis for such control. Under day work this need, while existent, is so obscured as to be comfortably ignored. Under piece work or premium systems of the Halsey type, as they are usually applied with considerable laxity on the part of the management in meeting its responsibilities, or in plain American, "passing the buck," it begins to make itself felt, but still not in an imperative way. Under task work, whether Taylor's differential piece-work system, Gantt's bonus plan or any other, where the highest rate of pay earned by a worker depends upon the performance of a predetermined and definite task under standardized conditions, in a definite time based upon elementary time study, routing becomes an absolute necessity. The mere fact that the worker's time on the job starts from the completion of his preceding job demands that his material shall be at hand, not a part sufficient to start on but the full quantity upon which his time is set; his tools, drawings and instructions must also be there, and experience has shown that without such control as the routing system affords these things cannot be counted as certainties.

At this point it may be well to step back to the source from which

work to be done originates. In the case of all products manufactured for sale this is either directly or indirectly a purchase order from the customer. To facilitate the work of planning it is advisable to transcribe customers' orders into a shipping order form. In so doing the customer's order is translated into shop terms and any ambiguity or question as to just what is wanted is cleared up.

A form of shipping order that, with suitable modification, has proved satisfactory in a wide variety of businesses is shown in Figure

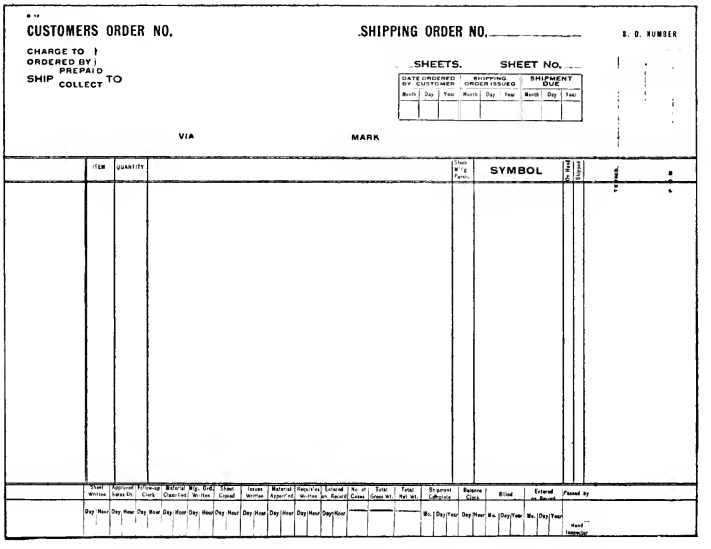

FIG. 55. CUSTOMER'S ORDER TRANSLATED INTO A SHIPPING ORDER

55. It will be noted that this form provides at the bottom of the sheet for indicating and recording performance of the several operations or steps necessary in handling the transaction from receipt of the customer's order to its shipment. This is an application in a simple form of the same principles and means that have been developed for the planning and control of manufacturing. It is in effect a route sheet for the transaction. All of the steps provided for may not be necessary in all cases and those not needed are crossed out.

In the case of a shipping order calling for articles carried in stock, their deduction on the balance-of-stores or stock-ledger sheets from quantities available, as will be later described, results in due time in

a minimum balance being reached and consequently in the issue of a manufacturing or production order for the replenishment of stock. If the article ordered by the customer is something not carried in stock, and which must therefore be manufactured especially to fill the order, a manufacturing or production order is issued. A typical form of manufacturing order is shown by Figure 56. It will be noted that this provides along the bottom for indicating and recording progress of the order through the necessary stages of design and planning.

B D 6

MANUFACTURING ORDER M V ½ x 3 5/8 Z F 1

FOR Stock

ORDER ISSUED			WANTED		
MONTH	DAY	YEAR	MONTH	DAY	YEAR
7	26	20	9	1	20

100- ½" x 3 5/8" Filister head bolts as per Drawing 52205-102.

	ORDER WRITTEN		APPROVED MANAGER		DRAWINGS PREPARED		ROUTING		FOUNDRY TAGS WRITTEN		MATERIAL APPORTIONED		TAGS ORDERS, ETC. WRITTEN		TIME STUDY		ROUTE FILE PREPARED		FINISHED		
CHECK	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	MONTH	DAY	YEAR
DUE	26	4	26	5			26	8			27	2	26	9	27	3	27	4	8	30	1920
SIG.	CC		LJ		X		F		X				MC								
FIN.	26	3	26	5			26	7					26	8							191

FIG. 56. MANUFACTURING OR PRODUCTION ORDER

From an extreme of simplicity, requiring little or nothing in the way of routing, the next step up is the manufacture of parts, such as ordinary cap screws or filister head bolts, having but one or two operations; in other words, parts that can be completed in one machine.

Upon receipt of the manufacturing order and drawing, the route clerk, who, by the way, is not strictly speaking a clerk but rather a practical man,[1] fills out the sheet from which a clerical assistant writes:

[1] Taylor used the term "clerk" to designate all employees in the planning department, including those filling the major functions. In recent years there has been

(1) the stores issue, or order, on the store room, calling for the required materials used for its apportionment and deduction from quantity on hand on the balance-of-stores sheets, and later serving to charge it to the cost of the order; (2) an identification tag to be attached to the material; (3) a move order which, when the job is to be started in the shop, will be issued by the planning department to a move man (a special laborer whose duty it is to move materials according to move orders only) who will get the material from the store room and deliver it to the machine indicated; (4) an operation order (in duplicate) for each operation, one copy to be placed, after the material is delivered, on the shop bulletin board and the other on the planning department bulletin board, showing work ahead for the machine in question; (5) a time card or job card for each operation, to be issued to the workman when he starts work upon the job, and to be used as a basis for paying for the work done and making up the cost of the order—also for the purpose of notifying the planning department of the operation being finished and recording that fact on the route sheet; (6) an inspection ticket for each operation, to be issued to the inspector at the start of the job, so that he may give the operator needed instruction as to the degree of accuracy or the kind of finish required, see that he understands the drawing and that the first piece is correct, and record the final inspection, on the completion of the operation, of all pieces; (7) a move order for each operation, for moving the materials to the next place in the manner previously described; (8) a worked-materials-received-in-stores slip, authorizing the storekeeper to receive the materials, from which the storekeeper posts his bin tag, from which the balance-of-stores clerk posts the balance sheets and closes out the manufacturing order as completed, insofar as process is concerned.

In all this two things are significant. One is that the people in the shop are practically relieved of the necessity of doing any clerical work and the other is that as much as possible of the clerical work is done in advance.

The various forms are placed, in the order in which they are to be used, in an envelope sheet to which the route sheet is attached. (See Figures 57 and 58.) These envelope sheets are made of heavy, tough paper. They are provided with as many small envelopes as there are operations to be performed and with one large envelope to contain the detailed instruction cards for each of the operations. The route

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a tendency, growing out of a time-honored aversion of shop men to being called clerks, to dignify these important positions by the title of "supervisor." Thus we have the production supervisor, the routing supervisor, the methods supervisor, and so on.

sheet and envelope sheet, when all planning operations have been finished, are turned over to the shop order-of-work supervisor (one of the

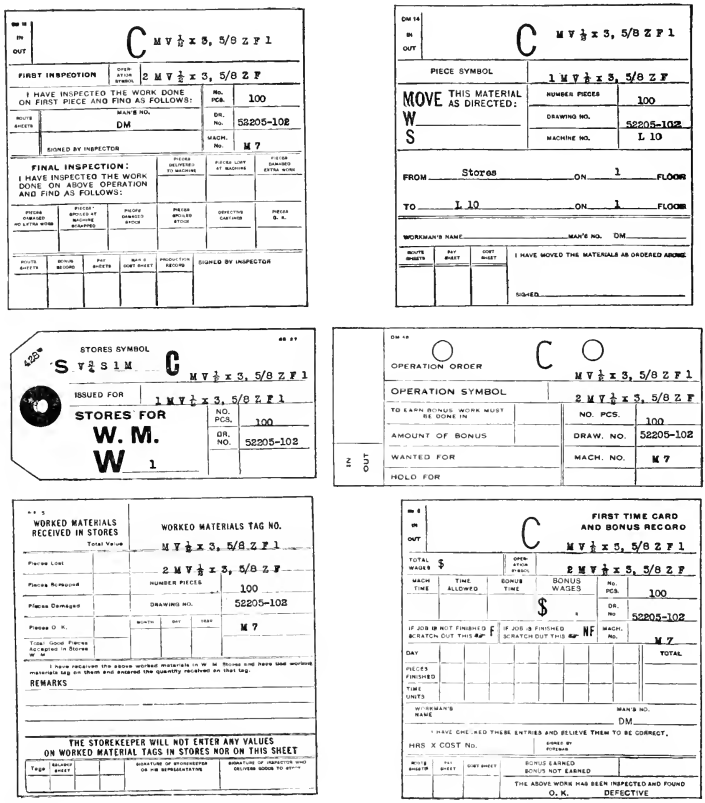

FIG. 57. VARIOUS FORMS USED TO CONTROL MATERIALS AND WORK ON A MANUFACTURING ORDER

functional foremen in the planning department) who places it in a suitably indexed route file and starts it out in the shop.[1]

[1] Numerous variations in the form, as well as in the manner of use, of so-called "piece-route sheets," or route sheets for indicating the work to be done and recording progress on jobs consisting of one or more identical pieces, have been worked out to suit the needs of particular businesses. Likewise there have been evolved methods of routing and carrying through in one lot a combination of articles differing somewhat in kind but having more or less similar operations to be performed

Later on the order-of-work function will be described and at that time the use of route charts, route sheets, and other products of the routing function will be gone into in full detail.

From the routing of simple individual parts the next step is the routing of an article consisting of several parts. The manufacture of such products consists in taking certain primary materials, either carried in stock or procured especially for the job, and by the performance of various operations thereon producing the elements or parts required. These parts, together with certain standard parts drawn from stores, are then assembled and we have the product. In planning the work the process is naturally reversed; we start with the assembled drawing and bill of material of the complete article (or, in what might be termed non-engineering industries, the equivalent in the form of specifications or samples) and first determine to what extent, if any, the article to be manufactured may be divided advantageously into units consisting of a number of parts which may be assembled independently and then assembled together, making the completed article. In a machine such as a reciprocating steam engine we would have several such major groups, which in turn might consist of two or more smaller assembled units, usually designated as divisions, and in certain instances divisions might include still smaller assembled units, designated as sections. Finally we get down to the elements or parts themselves.

Thus it will be seen that the process of routing an assembled product is analytical and conforms to the principles of classification.[1] In the case of the steam engine just referred to, our analysis would be somewhat as follows:

Product	PRINCIPAL SUBDIVISIONS *Groups*	SECONDARY SUBDIVISIONS *Divisions*
12″ x 12″ balanced slide-valve reciprocating steam engine with fly-wheel governor	Bed group	Base division Frame division Cross-head division Miscellaneous division
	Cylinder group	Cylinder division Piston division Valve division Miscellaneous division
	Crank and shaft group	Crank-shaft division Fly-wheel division Miscellaneous division
	Connecting-rod group	
	Miscellaneous group	

on each, at some, or all of the machines or work places. See an article by the author entitled "Controlling the Flow of Production," *Industrial Management*, Vol. LXI March, 1921, pp. 175-179.

[1] Cf. Chapter IX.

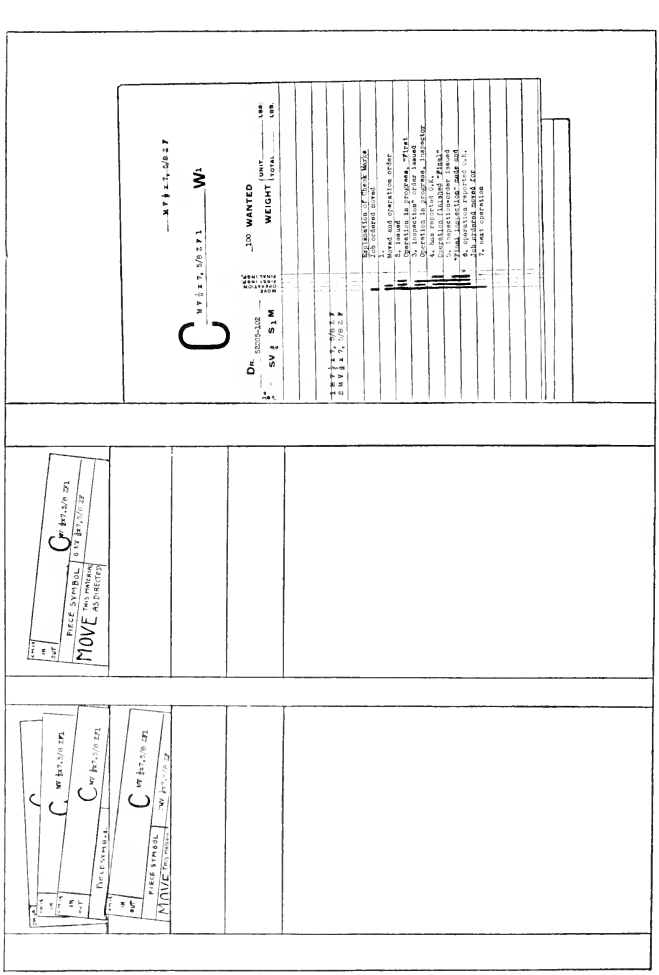

FIG. 58. SHEET OF ORDER FILE CONTAINING FORMS PERTINENT TO A MANUFACTURING ORDER

It has been found generally desirable that the classification for products should be worked out before taking up routing, at least so far as to cover the finished products of the company, its stores, and perhaps also the manufactured stock parts. In the case of our imaginary concern, about to build the engine referred to, the classification would be, let us say:

A to E inclusive—indirect expenses, departments and their activities
F
G
H
J
K Condensers
L Boilers
M
N
P Pumps
R Reciprocating steam engines
S (Stores)
T Steam Turbines
U
V Parts for use in a variety of products
W
X, Y, Z } Plant and buildings

Reciprocating Steam Engines

RA Automatic cut-off slide-valve engines
RB Balanced slide-valve fly-wheel governor engines
RC Corliss engines
RV Parts and accessories for use on a variety of steam engines

Balanced Slide-Valve Fly-Wheel Governor Engines

RBA
RBB
RBC Cross compound engines
RBD
RBE
RBF
RBG
RBH
RBJ
RBK
RBL
RBM
RBN
RBP
RBR
RBS Single expansion engines
RBT Tandem compound engines

RBU
RBV Parts and accessories for a variety of balanced slide-valve fly-wheel governor engines
RBW
RBX
RBY
RBZ

The size of the engine in question being 12″ cylinder diameter and 12″ stroke, we would give it the symbol R1212BS. Assuming this to be the first one, or the first lot manufactured (at least under the new system), we would add the figure one to the symbol, thus, R1212BS1, to be used as the manufacturing order number or charge symbol. It may not be out of place to explain here that using the symbol with a consecutive series of lot numbers for each lot of a given product or stock part takes the place of the usual single series of manufacturing orders for all products, with obvious advantages.

Having analyzed the construction of the engine, and decided upon the groups, divisions and sections, and compiled a list of the parts (elementary units entering into each), we would work up notes which, together with the drawing and bill of materials, would serve as the basis for our route chart. Symbols are assigned by which the order of relative importance and the order in which parts are used in assembling are indicated by part numbers placed between the last two letters designating the group and divisions. This would be done for each group, somewhat as follows:

R1212BS	Symbol of the product
R1212BSB	Bed group
R1212BSBB	Base division
R1212BSB1B	Base
R1212BSB2B	Pump and tank
R1212BSB3B	Rocker arm R. H.
R1212BSB4B	Rocker arm L. H.
R1212BSB5B	Rocker arm shaft
R1212BSB6B	Keys for rocker arm
R1212BSBF	Frame division
R1212BSB1F	Frame
R1212BSB2F	Main bearing cap R. H.
R1212BSB3F	Main bearing cap L. H.
R1212BSB4F	Main bearing quarter box
R1212BSB5F	Main bearing studs
R1212BSBH	Cross-head division
R1212BSB1H	Cross head
R1212BSB2H	Upper shoe
R1212BSB3H	Lower shoe
R1212BSB4H	Cross-head pin
R1212BSB5H	Adjusting screws
R1212BSBM	Miscellaneous division (This consists of

parts used in uniting the above divisions and attachments or accessories put on after the group is assembled. Usually there would be no assembling attached to this division as such.)

I will not take up space to show the symbols for the remaining groups and divisions which would be worked out in a similar manner.

In assignment of piece numbers to the parts making up the divisions there are two governing factors: (1) an order-of-work factor—the relative importance of the pieces in the division from the standpoint of time required to procure the materials and to perform the necessary operations thereon—and (2) the stage in the assembling at which the piece is to be used. Sometimes it happens that these two considerations coincide. In other cases it may be found that the first piece required for assembling is one for which the material is drawn from stock, with only one or two short operations required to make it. While a hard-and-fast rule cannot be laid down, it may be said that it is desirable to have the piece numbers indicate the preference to be accorded by those in charge of order-of-work functions in putting work through the shop, and also to have the parts appear on the route chart in consecutive numerical order for the benefit of those concerned with assembling. The route clerk must make the best compromise possible. Provided an order of work for the product in question is drawn off from the route chart no serious harm can result from a departure from either of these desired courses.

After having worked out our general scheme and classification of groups, divisions and units, we would next work up in the form of rough notes a description of the operations to be performed in assembling each division, in assembling the divisions and miscellaneous parts into their groups, and finally in assembling the groups (together with the parts and attachments contained in the miscellaneous group) into the complete machine. This may result in our making certain changes in the arrangement and classification reached as a result of our first analysis, which, of necessity, must be more or less tentative. As we work up our notes covering the operations of assembling, we determine the points at which various standard miscellaneous small parts to be drawn from the store room, such as cap screws, bolts, nuts, set screws, pipe fittings, and so on, must be used.

Finally we would work up our notes covering the operations to be performed in making the pieces, the machines, or work places at which each should be done, the quantity of raw material required for each part, and the source from which it is to be drawn.

It will readily be seen that to do this intelligently the functional

supervisor in charge of routing in the planning department must have, in addition to his practical knowledge, such data pertaining to plant equipment as will enable him to assign the various operations to the best suited machines. He must frequently consult with the time-study man with reference to the method and tools to be used, and if the quantities to be made and the possible savings seem to justify such a course, special tools may be ordered calling for quite different routing than if the ordinary standard tools were used. As a result of such conference he may take up with the designing department questions of slight change in design which would facilitate the work and save costs. (As a matter of fact in a concern operating under the Taylor System this most effective sort of cooperation usually takes place while the product is being designed.)

The route man must also watch the balance of work so as to avoid overloading certain machines while not providing sufficient work for others, and to this end he may indicate a preferred machine and an alternate or second choice. He must in the case of both machine work and hand work endeavor to separate into distinct operations work of a difficult character calling for a high degree of skill and work of a rough or simple character that can be done just as well by a comparatively unskilled and low-priced worker. He must keep machine operations clear from hand work which would have to be done by the machine operator and must route the job accordingly, otherwise his machine will stand idle while such operations as laying out, chipping, and so on, are being done, which can just as well be done on a surface plate, the floor, or a bench by another man. From the foregoing I think it will be apparent what type of man is needed for the routing function. It is a man-sized job.

All of this may be brought out by discussing a concrete case. The small special valve shown by the assembled drawing in Figure 59 offers an example of the simplest kind, consisting in all of only eight parts and permitting assembly as a single unit. The route chart in Figure 60 is so simple as to make explanation almost unnecessary.

The symbol MV½UY at the right indicates, according to the Tabor Manufacturing Company's classification of products: (1) that it pertains to molding machines, by the letter M; (2) that it may be used in the construction of various kinds of molding machines (a stock part limited to use on that class of products), by the letter V; (3) that it is a valve, by the letter U; (4) that it is a three-way valve, by the letter Y. The size is indicated by the figure ½ preceding the letter U, which it qualifies. As the letter T, which might have been used to indicate the kind of valve, "three way," had already been employed to designate another type of valve, the letter Y was selected

as to some extent mnemonic, by reason of its shape and the fact that it is the final letter of the descriptive term.

1. *Especially Purchased Materials.* The letter P to the left of the brackets, embracing Pieces 1, 2, and 3, indicates that the castings (primary materials) are to be purchased especially for the order as

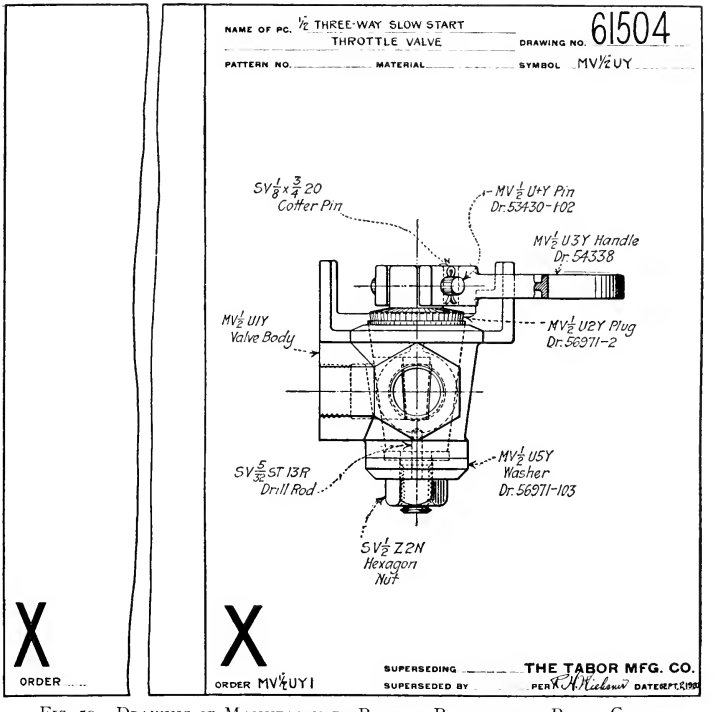

FIG. 59. DRAWING OF MANUFACTURED PART AS PREPARED FOR ROUTE CLERK

they are not carried in stock. Any special materials to be procured would be so indicated and requisitions on the purchasing agent drawn accordingly by the special-materials clerk, whose duty it is to order and follow up their procurement. In a machine shop, as most of the materials to be especially procured are castings, the clerk charged with this function is usually called the foundry clerk. Forgings also come under this head if the company is not equipped to make them. Even where a company operates its own foundry it is better, by

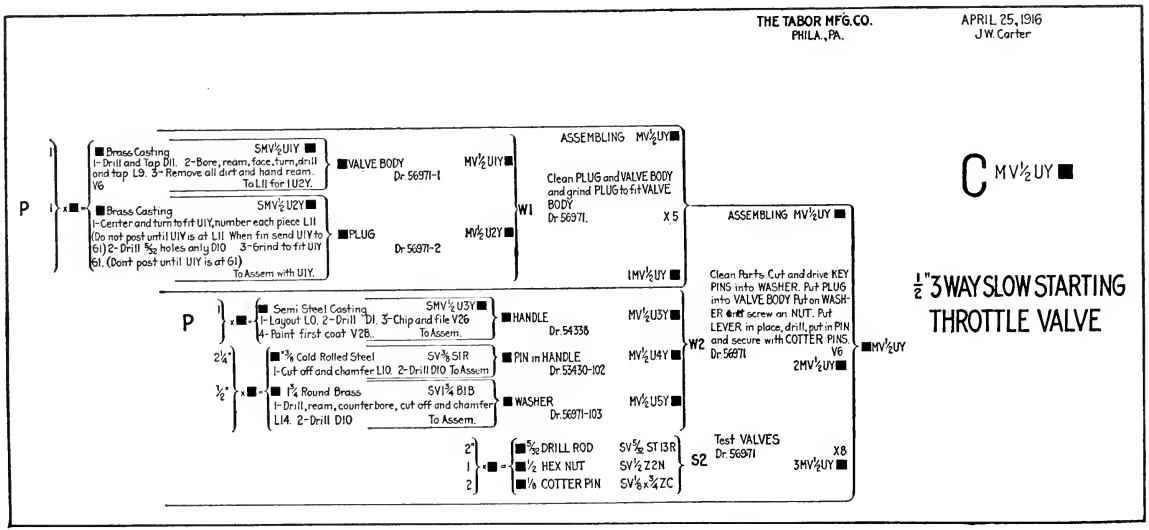

FIG. 60. ROUTE CHART OF ITEM SHOWN IN FIG. 59

reason of the differences in methods of planning and operation, to treat castings as though procured and not to attempt to show the foundry work on the machine-shop chart. The same would hold good in the case of articles or materials to be manufactured in another plant of the same company more or less remotely located and not controlled (except in a broad way) from the same planning department.

The figures to the left of the materials from which the parts are to be made, or parts taken from stock, give the unit quantities required for making one unit of the product (in this case one valve). In the blank square following is entered the figure by which the unit quantity must be multiplied to give the quantity required for the lot. The latter number is entered in the square preceding the description of the material specified.

Opposite the description of materials is shown the stores (purchased-material) symbol. In the case of Pieces 1, 2, and 3, it will be noted that the stores symbol consists of the worked material or part symbol with the letter S, denoting stores or purchased material, prefixed. This shows that they are special classified stores; *i.e.,* their use is limited to a single class of product or subdivision thereof. If circumstances make it desirable to carry such parts regularly in stock the letter P would not appear preceding them.

Under the description and symbol of the material for each part are shown the operations to be performed and the machine in which each must be done. For example, piece MV½UY must first be drilled and tapped on Drill Press No. 11 (D11); next it goes to Lathe No. 9 (L9) for the operation indicated, and is finally delivered to Lathe No. 11 (L11) to be used in connection with the first operation on the second piece, 1MV½U2Y. Attention is called to the note in connection with this operation reading, "Do not post until U1Y is at L11," which means, "Do not issue the operation order, and so on."[1]

In notes such as this, and in speaking of work on parts, groups, or divisions of a given lot of product, it is common practice to abbreviate the symbol, the portion dropped off being understood. In deciding this point, when the job was originally planned, it was necessary for the route man to consider whether or not the quantities to be made would justify the making of special gauges to obviate the necessity of turning the plug to fit the body. If so, it would be necessary to

[1] The symbols for machine tools here given while satisfactory for a comparatively small plant would not be adequate in a large one. For example, L9 happens to be a chucking turret lathe and L11 an engine lathe, sixteen inch swing. It would be better practice to indicate the type of lathe by a second letter; thus, LE, engine lathes, LT, turret lathes. The size should be inserted between the letters and each of these subclasses of lathes given its own series of numbers. In a large plant it might be desirable to further subdivide by the use of a third letter, as LTC, chucking turret lathe, LTS, screw machine (working from bar stock, and so on).

order these tools. In such matters he would consult the production clerk and the time-study man.

Notes such as those just referred to are shown on the route sheets (see Figures 61 and 62) and govern the shop order-of-work man, and his assistants at the bulletin board, in controlling the progress of work. The importance of these notes is obvious.

The description of the operations to be performed on the parts, while brief, must be sufficient to indicate to the man who will prepare the instruction cards describing the operation in detail just what work is contemplated. This is especially important in case there should be

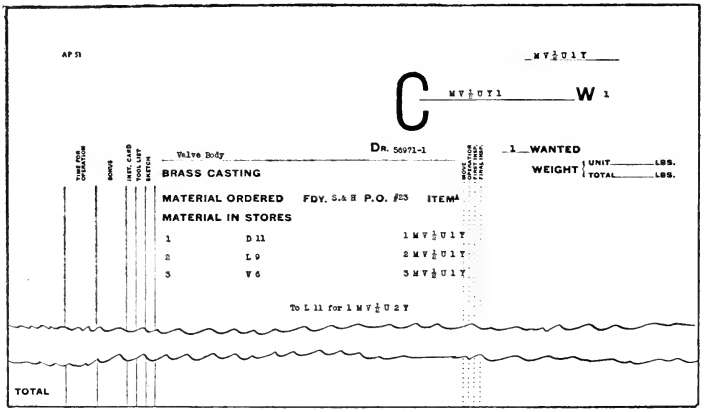

Fig. 61. Route Sheet with Notes for Guidance of Order-of-Work Clerk

at different stages operations in the same or similar machines, as is not at all uncommon in complicated parts.

To the right of the bracket enclosing each part is given the name of the part, the drawing number (for which in some businesses the symbol of the part may be made to serve), the pattern number in the case of castings (which in this instance is the same as the drawing number), and the symbol of the part. The blank spaces preceding the names of the parts are for quantities and those following the symbol are for the lot numbers.

2. *Routing Chart Arrangement and Design.* The diagrammatic arrangement of the chart is important. It is quite evident that Piece No. 1 is, from an order-of-work standpoint, the most important by reason of its being the most difficult casting to make, the amount and character of work to be done on it, and the relation it bears to Piece

No. 2. It is likewise evident that Piece No. 2 is next in importance. The chart shows, as do the route sheets also, that when the machine work has been finished on these two parts we may issue the operation order 1MV½UY to assemble them at work place X5. The two pieces will have thus become a unit, W1.

That Pieces 3, 4 and 5 are not required to be finished until Pieces 1 and 2 have been assembled is clearly shown by their location on the chart. On account of this, their simplicity and the small amount of work to be done upon them, they are relatively unimportant from an order-of-work standpoint. With very little attention of the shop

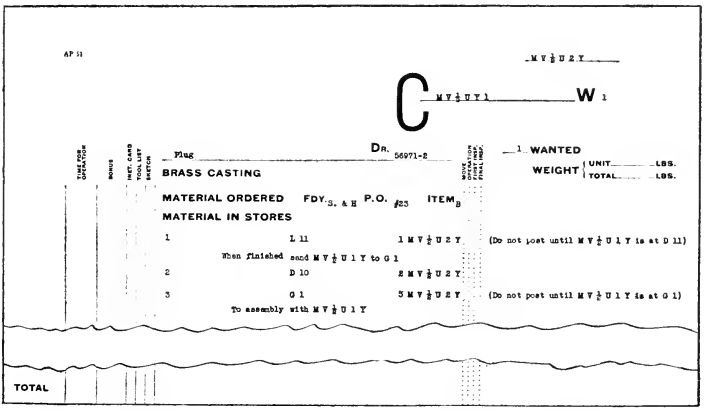

FIG. 62. ROUTE SHEET WITH NOTES FOR GUIDANCE OF ORDER-OF-WORK CLERK

order-of-work supervisor or his assistants, they may be depended upon to be finished before they are needed. As a casting must be procured for Piece No. 3 it is more important than Pieces 4 and 5, the materials for which are carried in stores.

When Pieces 1 and 2 have been assembled, if Pieces 3, 4 and 5 have been finished and delivered to the assembling department and the stock parts, grouped in the bracket S2, issued from the store room to the assembling department, the operation order for performing the second assembling operations 2MV½UY at Vise No. 6, and upon its completion the final operation 3MV½UY at work place X8, would be issued.

At the assembling department is established a section equipped with bins and sufficient floor space for the storage of parts ready for assembling as they are received from the machine department and the store room.

This section, which is in effect a special store room, is in charge of a man called the assembling-department stockkeeper whose duty it is properly to place materials as received, and to deliver and see that they are properly placed at the assembling work places sufficiently in advance of the time required, as indicated by the operation orders on the shop bulletin board. When work or an order for a lot of products is started in the shop, the shop order-of-work supervisor sends a set of charts (which would also be used by the workmen and functional foremen in the assembling department) to the assembling-floor stockkeeper who sets aside and marks a sufficient number of bins to receive the parts as they arrive. (See Figure 63.) In the case of the valves under discussion he would reserve one bin (compartment) for the parts for the first assembled unit, W1, and another for those to be used in the second stage of assembling, W2 and S2. He would mark the bins assigned accordingly. Large parts are placed in space assigned on the floor. The terms W1 mean worked-material Issue No. 1; W2, worked-material Issue No. 2; S2, store Issue No. 2. The purpose of these marks is to indicate the stage at which parts are required for assembling, what items should be issued from the store room together for assembling, and what the assembling stockkeeper should gather and deliver to the assembling work places at the same time.

So far as the shop is concerned the use of the route charts is limited to the assembling department. While assembling operations are clearly defined on the chart, they are covered, as are operations on individual pieces, by instruction cards prepared by the time-study man. These describe each operation in greater detail, element by element, and give the time the work should take.

The symbols for the miscellaneous classified stores used, to anyone familiar with machine shop practice will be easily understood. For example, the material from which MV½U4Y is made, is expressed by the stores symbol SV⅜S1R. S indicates that it is purchased material or stores; V, that it is miscellaneous classified stores which may be used for a variety of purposes, or in the manufacture of a variety of products; S, that it is steel; R, that it is cold rolled steel. The figure 1 between the last two letters denotes that the shape is round, and the diameter, three-eighths of an inch, is shown between the letters V and S.

In the case of the material for MV½U5Y with the symbol SV1¾B1B, the first letter B indicates brass and bronze and the second B the quality—ordinary yellow brass.

In the case of the "hex" nuts (Symbol SV½Z2N) and cotter pins (Symbol SV⅛¾ZC) included in S2, the letter Z denotes that they belong to the broad class of holding devices, the letter N reduces

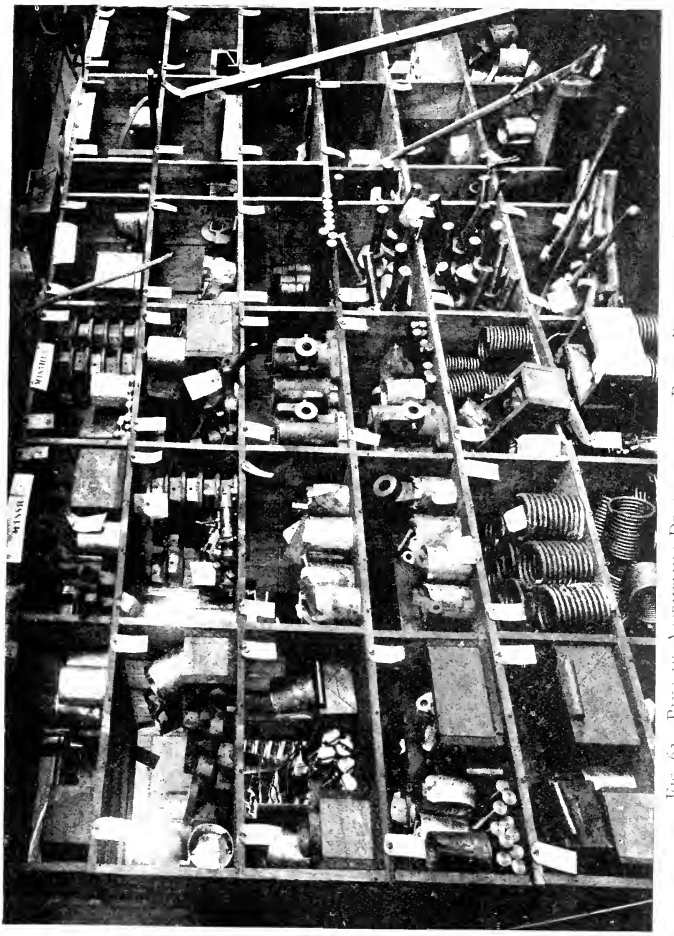

FIG. 63. BINS IN ASSEMBLING DEPARTMENT FOR PARTS READY FOR ASSEMBLING

the class to standard nuts, and the figure 2 indicates the shape—hexagon. SVZ1N would designate square nuts.

It will be noted that the route sheet for assembling (Figure 64) provides spaces at the top for checking off, as they are finished and moved to the assembling department, each of the parts made especially for the order, and that the piece-route sheet (Figure 62) shows this checking as the last thing to be done when the move order has been returned by the move man. The parts are grouped as on the route chart according to the W and S numbers, or, in other words,

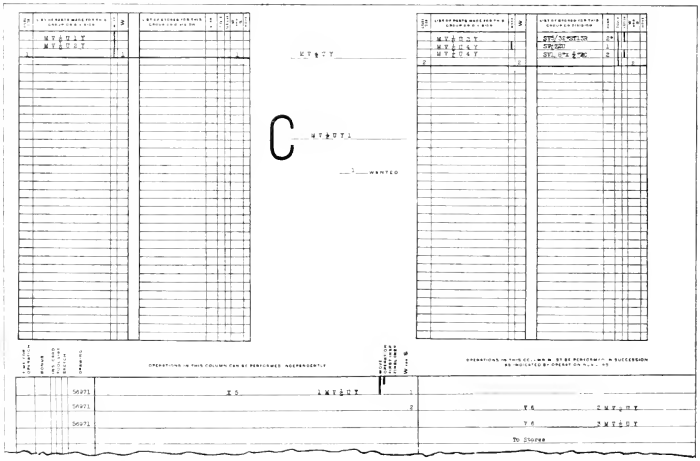

FIG. 64. ROUTE SHEET. CHECKS IN VERTICAL COLUMNS INDICATE THAT PARTS HAVE BEEN MOVED TO ASSEMBLY DEPARTMENT

according to the assembling operations in connection with which they are to be used.

For Operation No. 1 (1MV½UY) we see that only pieces U1Y and U2Y are needed and that nothing is to be drawn from stores. Therefore, when the recording clerk has checked these two pieces (as shown), he will issue the operation order for the first assembling operation. In the case of the second assembling operation, 2MV½UY, it is clear that we may not post the operation order until we have finished operation 1MV½UY and have delivered pieces U3Y, U4Y, and U5Y. We must also send the stores issues (orders on the store room) to the store room, requiring a move man to deliver the materials grouped under S2 to the assembling department. Checking

spaces which are used as follows are provided opposite each of these items: (1) When materials are apportioned, the quantity required for the article, as indicated on the balance-of-stores sheet (see Figure 65), is entered in the column headed "apportioned but not yet issued"; added to the previous balance, and subtracted from the balance in the column headed "available." As this transaction involves ordering to replenish stock whenever the available balance reaches the established minimum, the balance clerk makes a check mark on the route sheet in the checking space headed "ordered." (2) When the proper time arrives to start work in the shop, if materials which may be used for

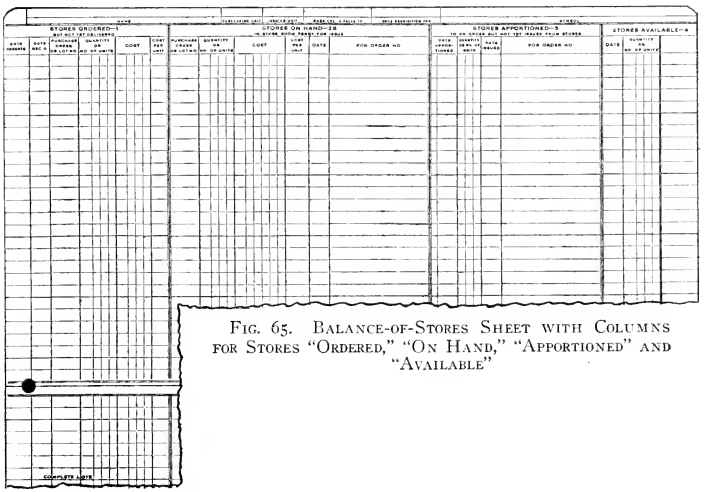

FIG. 65. BALANCE-OF-STORES SHEET WITH COLUMNS FOR STORES "ORDERED," "ON HAND," "APPORTIONED" AND "AVAILABLE"

the job in question are shown to be actually on hand by the "on hand" column of the balance-of-stores sheet, the balance clerk assigns the material by making an entry in the "on hand" column and subtracts the quantity of material required from the balance previously shown. This definitely reserves it for the order. He then makes a check mark in the checking space headed "in stores." It should be noted that apportionment must be made at the time work is being planned in order that provision may be made for having stock on hand when it is wanted. Assignment, however, may be made either at the same time as apportionment or at such later time as the case permits or demands. (3) The third checking space for "material prepared" is to be checked with a half check mark when the stores issues are sent to

the store room. The check should be completed when they are returned by the storekeeper, so that others may be informed that he has got them out and placed them in containers to which he has attached the identification tags sent him with the issues. The next step is to issue the move order for their delivery to the assembling department, and to make a half check mark after the order. When the move man has returned the move order, showing that he has delivered the materials, this check mark should be completed.

Usually the recording clerk takes the steps necessary to have materials delivered from stores to the assembling department before the completion of the last part especially manufactured. His object is to avoid delay in starting the assembling operation and at the same time to avoid having an unnecessarily large quantity of inactive material out in the shop.

From the route charts a typist writes, either on the machine or by hand, a route sheet, such as Figures 61 and 62, for each part to be made especially for the order, as well as an assembling route sheet, such as Figure 64, for each group, division, or section. As in each of the cases used for illustration in this article the complete product is treated as a single group with no divisions or sections. There is, of course, but a single assembling route sheet. The necessary operation orders, move orders, time (or job) cards, inspection orders, identification tags and stores issues, for each part and assembled unit, should be written and placed in pocket sheets to which the route sheets are attached. All this, as the reader will recall, has been described previously. These papers are then to be placed in a route file in the order indicated by the symbols, and the operation of routing is complete.

While it is, of course, desirable to take each step from the design to the completion of planning in turn, following a logical sequence, it is also possible, in case greater speed is necessary, to have several blue prints made from the route chart and to carry out each of the functions of planning from these simultaneously. To expedite matters, patterns, and even castings or other special materials, may likewise be ordered from the bill of material, or even from the drawings, as fast as they are made. Route sheets bearing temporary symbols may be put through, for certain parts upon which work may be in progress, before the route chart is finished. I recall one such instance in which a large machine was designed, built and shipped in three weeks. Work on that machine was going on simultaneously in the drafting room, planning department, the pattern shop, foundry and machine shop, all in accordance with the system. The planning followed close upon the heels of design and kept just ahead of the shop. Such a

course is seldom necessary and is not good practice, as it calls for such a degree of personal follow-up as must inevitably result in neglect of other work and loss of production. It is a good "stunt" rather than good management. I mention it only to show that the system I am describing is not inflexible. This discussion belongs more properly, however, to the order-of-work function than to routing.

The advantages resulting from the control of assembling that are made possible by routing will be readily apparent to any one who has ever acted as foreman or superintendent of a shop in which assembling is an important part of the work. In such a plant under the ordinary plan of operation—by which workmen start on operations that cannot be completed, hunt for parts that have been lost or through oversight were not made, discover at the last moment that certain stock parts needed in assembling are not on hand, correct faulty machine work resulting from imperfect understanding of requirements, etc.—more time is wasted in doing these things than is spent in actual productive work. *I have personal knowledge of one plant in which the assembling production per man was increased sixfold.* While this increase was in part due to the better machine work resulting from systematic instruction and inspection, and to better assembling methods and bonus work resulting from time study, it was in the main due directly to routing. In the last analysis it was entirely due to routing, as without routing the contributing causes might never have existed.

While I have dispensed with route charts in several plants which might be classed as nonengineering, manufacturing comparatively simple products, and obtained results which have been eminently satisfactory to my clients, I am more and more convinced, as my experience broadens, that it is advisable and profitable to use them in connection with the manufacture of any product involving the production and assembly of several components into a completed product. We have considered so far only the route chart of a very simple article, because it is something easily understood, and because my readers engaged in other lines of industry should have little difficulty in translating the language of the machine shop into their own shop language. If one were to change the names of the component parts, of materials and of operations, making a few additions or omissions, it would look much the same for a paper box and its contents, for a combination ash tray and match holder, a shirt, a pair of shoes, or a tobacco pipe. Also, the chart used represents an assembled unit which goes to make up a division or group, consisting of two or more such units assembled with miscellaneous parts and accessories.

Thus it will serve as a basis for understanding the more complicated case to be taken up next. Figure 10 (used as an illustration for

Chapter IX, page 128) presents the chart M15183JP which, as the symbol indicates, is for a molding machine of the plain jarring type having a table 15″ x 18″ and operated by a 3″ cylinder. It goes just one step beyond the chart for the valve, as it includes two units consisting of parts that may be independently assembled and then assembled together with certain other parts.

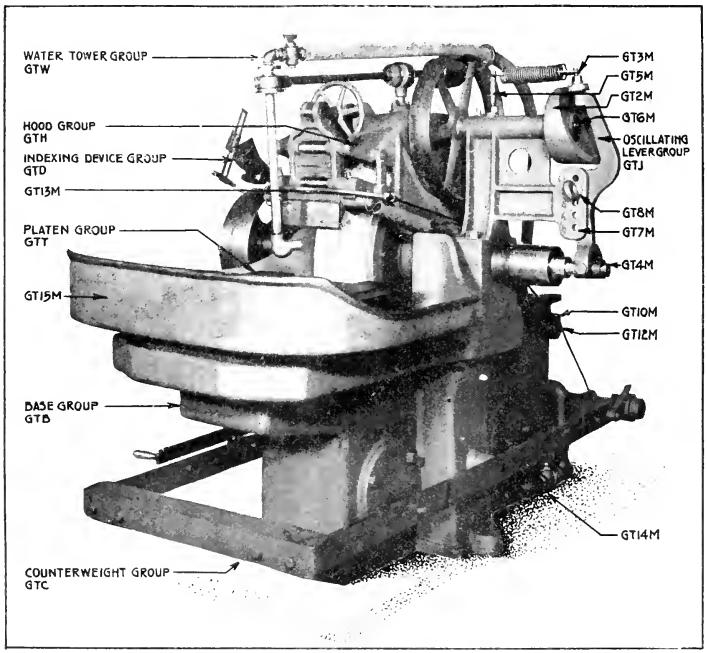

Fig. 66. Automatic Machine for Grinding Tools. Note Parts and Their Symbols

Having described the route charts for very simple articles assembled as a single group, the next step is to describe the routing of a machine, somewhat comparable to the steam engine referred to.

The photograph in Figure 66 shows the automatic machine which Taylor developed and first had built while he was at Midvale. This was used for grinding cutting tools, for lathe, planer, and boring-mill work, to the shapes and angles adopted as standard. This machine, and the standard tools that it grinds, are some of the fruits of his

investigation in the art of cutting metals, which started with his early efforts to set honest piece rates.

I have selected the route charts for the Taylor grinder because it presents practically all of the features that may be encountered in the

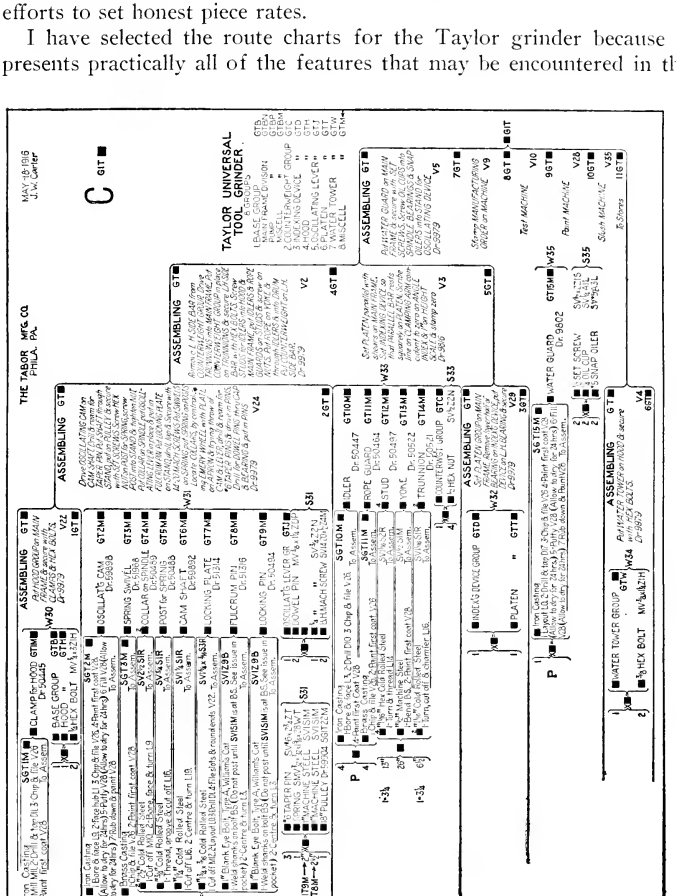

FIG. 67. ROUTE CHART FOR MACHINE SHOWN IN FIG. 66

routing of any fabricated article, and at the same time it is simple enough to be readily understood. Figure 67 is the diagram, or chart, showing the final assembling of the machine. The list under the title at the right indicates that the machine may be divided into eight prin-

cipal groups, seven of which may be assembled independently before being combined with the parts making up the miscellaneous group. One of these, the base group, is made up of three divisions, two of them independently assembled, and a miscellaneous division consisting mainly of parts used in putting together the divisions GTBN and GTBP.

It will be seen that the several groups appear on this chart as single units, just as though they were taken already assembled from stock. Two of them, GTB and GTH, are required for the first assembling operation, 1GT, and the others are called for as the work progresses. It will be noted that the location on the chart of the groups for final assembling, rather than the alphabetical arrangement of the list of groups at the right of the diagram, fixes their relative importance, from an order-of-work standpoint. That the base group should appear first in both cases is a coincidence in symbolizing. A study of the chart reveals the fact that until the base group and hood group are put together no other operations of the final assembling may be done. Operations 2GT, 3GT and 6GT may, however (providing the parts are ready), be done simultaneously by three different men of different degrees of skill, thus reducing the time the machines will take up space on the assembling floor. It will also be apparent that while Operation 6GT may be performed any time after Operation 1GT, it need not be done until after the fifth operation.

Sometimes we learn as much from observing the imperfections of the object we are studying as we do from having its good points brought to our attention. In the diagram under consideration there are three defects or, rather, deviations from the rule.

The first of these faults is that the diagram is drawn as if the indexing device group, GTD, and the platen group, GTT, were to be united by the performance of Operation 3GT. The fact is that they are to be united with the base group and the hood group, which were brought together by Operation 1GT. Two courses, either of which would have conformed to the rules, lay open to the route man. One was to place the two groups concerned, and Operation 3GT, in the same section of the chart as the units assembled by Operation 2GT, and the other was to place them in the section pertaining to Operations 4GT and 5GT. Either course would not, however, provide for performing the operation independently of Operations 2GT, 4GT, and 5GT and this seems to account for the compromise. The second defect, in the case of Operation 6GT, is similar to the one just cited, and since the group GTW was more or less in the way, it was a question whether it might not be better to defer this operation until after

Operation 5GT. For this reason the operation is designated as 6GT instead of 4GT, as would otherwise seem more natural.

The third point open to criticism is that there seems to be no particular reason why Operation 4GT should not have been treated in the same manner as Operation 6GT. As shown, it would seem that Operation 5GT could not, or should not, be performed until after Operation 4GT, but this does not appear to be borne out by the construction of the machine, as shown by the photograph in Figure 66.

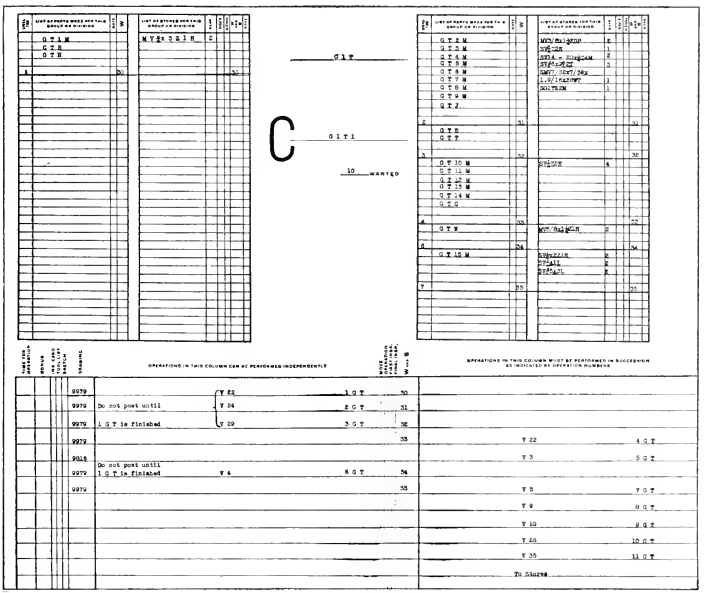

FIG. 68. ROUTE SHEET FOR ASSEMBLY GIT.

From a practical standpoint, however, these defects, if indeed they may be so called, are harmless. I have commented upon them only to show the sort of questions that the route man must decide in making a chart and to show that, even with the best of routing, the person handling the shop order-of-work function must understand the route charts and be competent to exercise good judgment. He will always play safe if he follows the steps in the numerical sequence laid down by the route chart (and the assembling route sheet). In order to shorten the time required for assembling, or to keep men supplied

with work, in a pinch, however, an intelligent reading of the route chart, and possibly consultation with the route man, may make certain

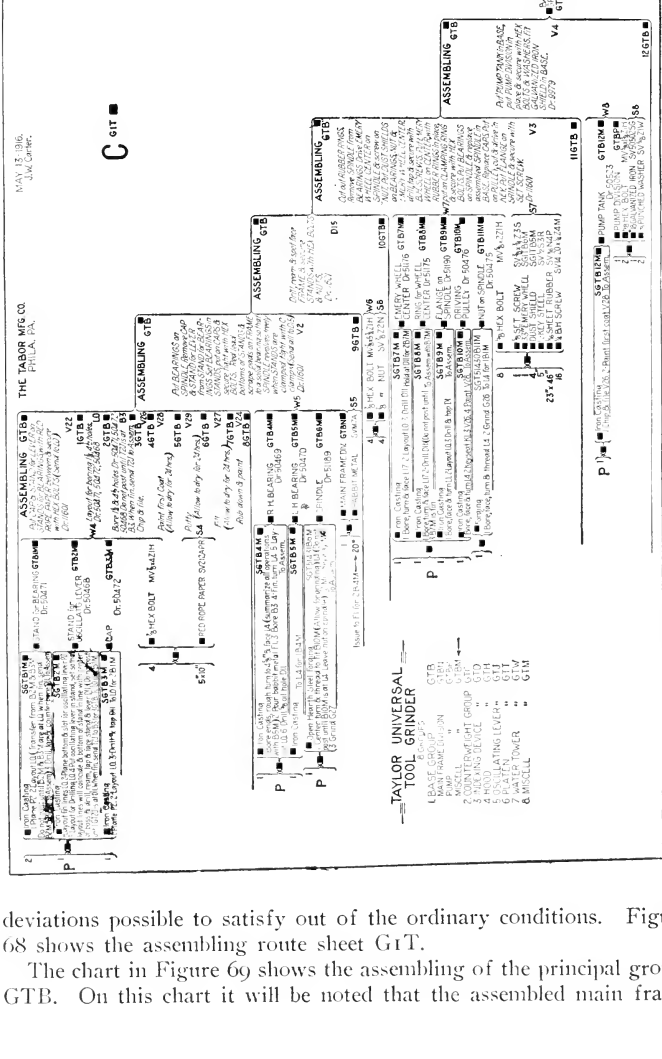

FIG. 69. ROUTE CHART FOR ASSEMBLY OF GTB GROUP

deviations possible to satisfy out of the ordinary conditions. Figure 68 shows the assembling route sheet GIT.

The chart in Figure 69 shows the assembling of the principal group, GTB. On this chart it will be noted that the assembled main frame

division, GTBN, and the pump division, GTBP, are shown as single items or units, in the same manner as are the parts constituting the miscellaneous division with which they are united to make the complete base group. In the final assembling of this group there are no units that may be assembled simultaneously. The parts grouped in the section W4 and S4 may, however, have Operations 1GTB to 8GTB inclusive performed upon them simultaneously with, or previously to, the assembling of the divisions GTBN and GTBP. Apart from this the assembling is a series of consecutive steps.

The most interesting feature of this chart is the interdependency of various parts. For example, in the case of GTB1M it is shown that

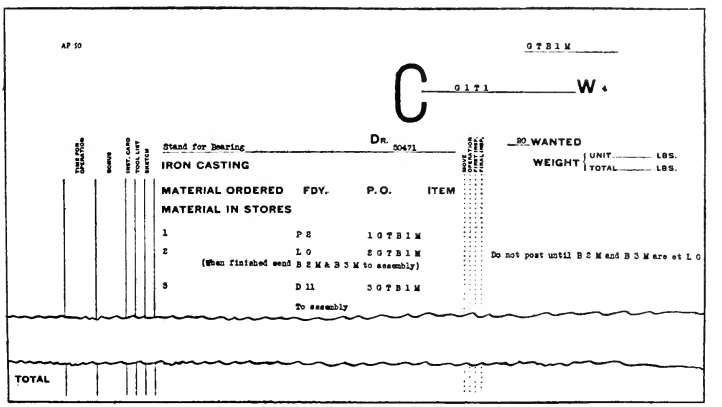

FIG. 70. ROUTE SHEET FOR PART GTB1M

the second operation may not be performed until Pieces GBT2M and B3M are finished and delivered to the lay-out table. Piece GTB2M may not be drilled (Operation 4GTB2M) until Piece GT2J from another group has had certain operations performed upon it and is delivered to Drill Press No. 11 (D11). See Figures 70 and 71 for the manner in which this is treated on the route sheets for the individual pieces.

As the two bearings, GTB4M and GTB5M, are quite similar, it is desirable that the several operations be performed on both at the same time. This is what is meant by the note "Summarize all operations with B5M" shown in connection with the first operation on GTB4M. (See route sheets in Figures 72 and 73.) The differences in the work on these two bearings, made according to different draw-

ings, will be covered in detail by the instruction card. This brings out the point that two or more different articles may be handled on the

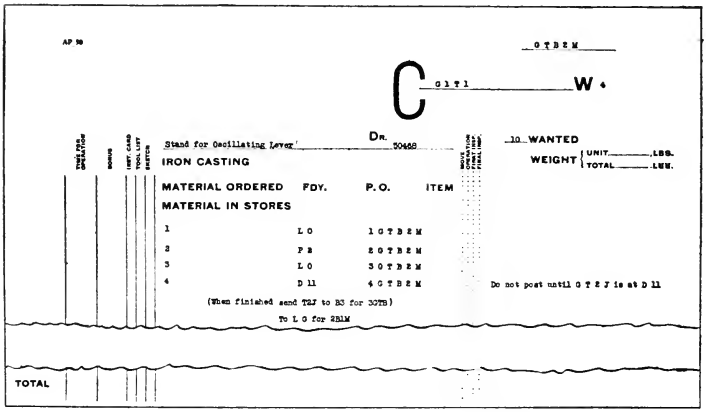

FIG. 71. ROUTE SHEET FOR PART GTB2M

same route sheet as a single job, where they follow the same route path; that is, when all, or most, of the operations are similar and may

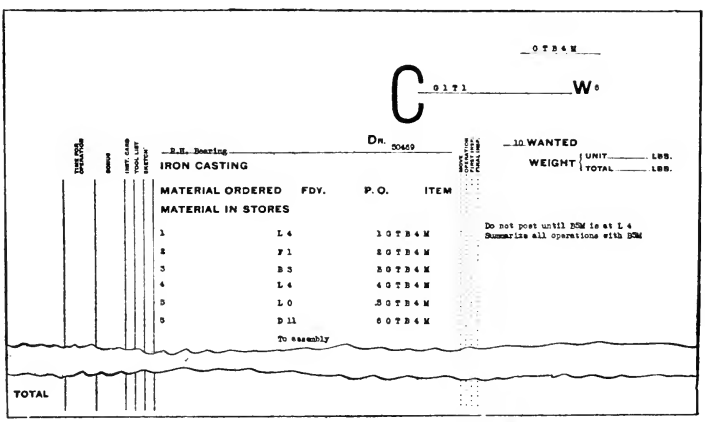

FIG. 72. ROUTE SHEET FOR PART GTB4M

be done at the same machine or work place. Such a procedure may be desirable from a mechanical standpoint, or to decrease the cost and

trouble incident to routing a number of small jobs separately, when they might be combined to gain some of the advantages of production in larger quantities. In some industries the combination of a number of more or less similar articles into one manufacturing lot is the only course economically feasible.

The interdependency of operations on various parts, commented upon above, is shown by notes on the route sheets for the parts concerned. The shop order-of-work supervisor and his assistants are governed thereby in regulating the performance of the work in the shop. Any one who has had experience as a foreman or superintendent of a shop handling a variety of work will appreciate the difficulties, and

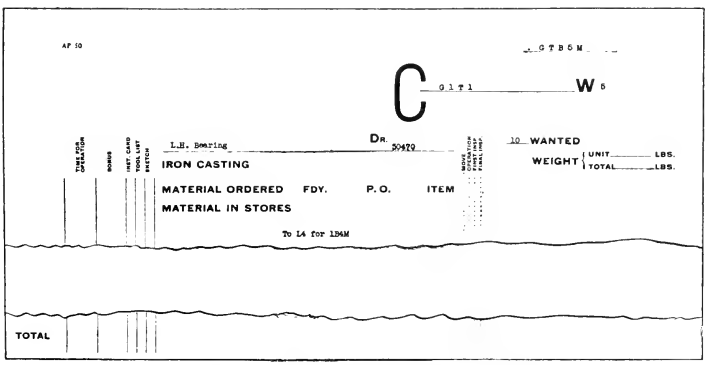

FIG. 73. ROUTE SHEET FOR PART GTB5M

the danger of errors, under the old way of doing things. Then such matters had to be planned largely on the spur of the moment, amid the hustle incident to shop operation, and were often left to be taken care of by the individual workmen, who might or might not be sufficiently familiar with the products to understand the requirements. Even under the best of circumstances lowered production was inevitable. To these men the value of orderly planning in advance, such as we have been discussing, will be at once fully apparent.

The question may be raised as to why the paint, putty, and filler required for Operations 5GTB to 8GTB are not shown on the chart. The reason is that it is impracticable to issue and charge to the manufacturing order for each job on which these materials are to be used the exact amount required. Hence they are treated as shop supplies, drawn from stores as required, charged to the appropriate departmental expense symbol, and distributed as indirect expense. The hourly cost

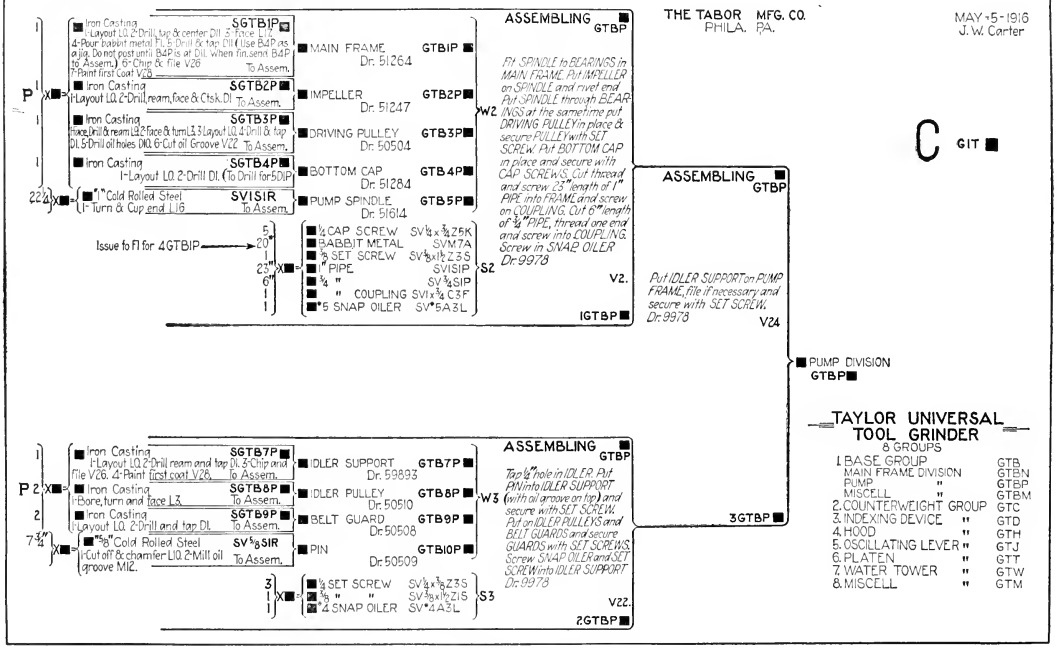

FIG. 74. ROUTE CHART FOR PUMP DIVISION (GTBP) OF BASE GROUP (GTB)

number (machine or work-place rate) for painting includes this item of expense.

Figure 74, the chart for the pump division of the base group GTBP, which is shown by the photograph in Figure 75, is a nice, clean-cut little diagram showing two units which are to be assembled independently and then united by the performance of Operation 3GTBP. The two units might have been given the following symbols to designate them as sections:

GTBPF—Frame section of pump division of base group
GTBPR—Idler section, etc.

The piece numbers would then appear in front of the section letter—GTBP1F, GTBP1R, etc. In a larger and more complicated machine this might have been desirable, but it would serve no real purpose in this case.

It has no doubt been observed that when the parts have been finished and assembled the symbol is shortened by dropping the piece number; when the divisions are united it is further shortened by dropping the division letter and similarly, in the final assembling, the group letter.

The reader may have some difficulty in understanding why the symbols of certain worked-material stores shown in Figures 70-74 should start with M. As a matter of fact this is due to a lack of foresight. When the original classification for the Tabor Manufacturing Company was drawn up they manufactured only molding machines, and hence, as such parts might be, and were, used on several types or classes of their product, they were symbolized as "parts for use in a variety of molding machines," indicated by the letters MV. Inasmuch as parts of the character referred to may be used in the building of any kind of machines, it was a mistake to have used the letter M. Accordingly, they should have been classified under the letter V to designate the main class. As such parts are sometimes manufactured and sometimes purchased, the simple prefixing of the letter S would then have brought them into their allotted place in the stores classification. This and other corrections have been made in the Tabor classification, but I have let them stand on the chart to emphasize the necessity for considering and providing for the possibility of new products when working up a classification. Changes and revisions after the system is well established are annoying and sometimes extremely expensive.

As the three examples shown cover practically all of the variations to be met in making route charts, I have not thought it necessary to reproduce the diagrams for the other groups of the tool grinder.

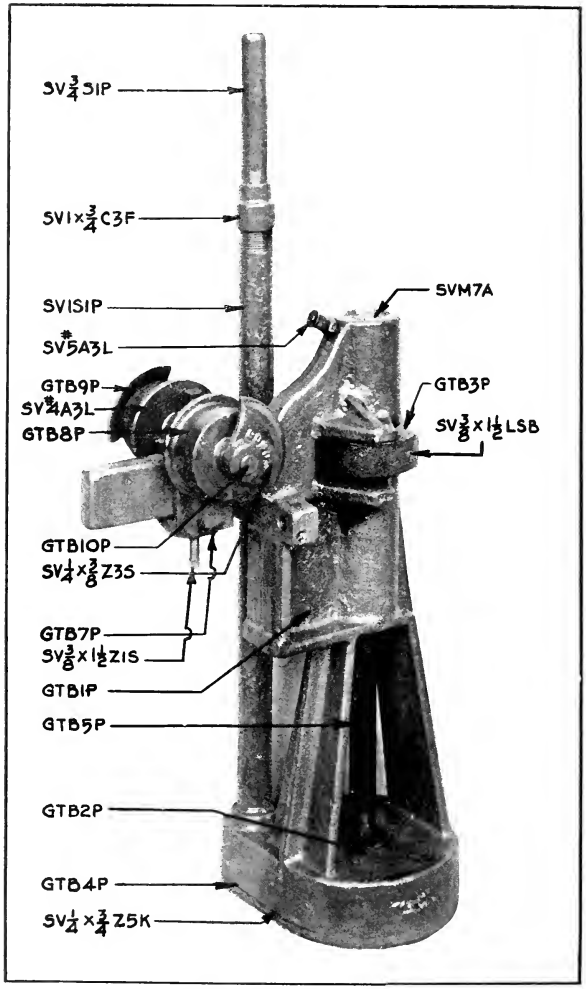

FIG. 75. PHOTOGRAPH OF PUMP DIVISION (GTBP)

Taylor, in explaining the construction of a route chart, used to liken it to a river into which flowed creeks that were fed by brooks into which flowed smaller streams. Mr. John W. Carter, who contributed to the development of routing in a paper presented before the Taylor Society in 1917, reversed this simile while in charge of that function at the Tabor Manufacturing Company. He compared the construction of a route chart to that of a tree, with the trunk representing the complete product; the limbs, groups; the branches, divisions, and the twigs, pieces.

Following out this line of thought, the reader will see that, if it were desired, the construction of the entire machine might be shown on one continuous diagram in which the divisions would flow progressively into the groups and the groups into the complete machine. Such a diagram would, however, be so unwieldy as to make its use almost impracticable. Hence it is the practice to show the details of each division and group on a separate sheet and to treat them as single units, in the same manner as the individual parts, on the chart for the next larger unit to which they pertain.

While the literature of scientific management has scarcely touched on the important function of routing, its development was well advanced thirty-three years ago, as will be borne out by reference to Figures 76 and 77, which are, I believe, the earliest examples of Taylor route charts. They were made in 1896 while he was engaged in installing his methods for the Steel Motors Company, of Johnstown, Pa. These charts, which are part of a set for a thirty-horse-power motor, are chiefly of interest from a historical point of view, in that they show the progress that Taylor had made even at that early date in the development of a mechanism of management. It will be noted that these charts do not indicate the source of special classified stores (SMC3H1A, etc.), and that while the operations on the various pieces are indicated the specific machines and work places at which the work is to be done are not given. This evidently was still being left for the order-of-work clerk to determine as the work progressed. Evidently it was at about this period that routing began to establish itself as an independent function.

The placing of the size at the end of the symbol for the completed articles, MC3 in Figure 76, is at variance with later practice and indicates that the scheme of using the symbol followed by a lot number had not yet been evolved. Today we would write it M3C and the order number, or charge symbol, would be M3C1 for the first lot, comprising the parts grouped as W1 and S1 (worked-material Issue No. 1 and stores Issue No. 1). According to the symbol MC3HA these constitute the arm division of the brush-holder group and of a miscellaneous

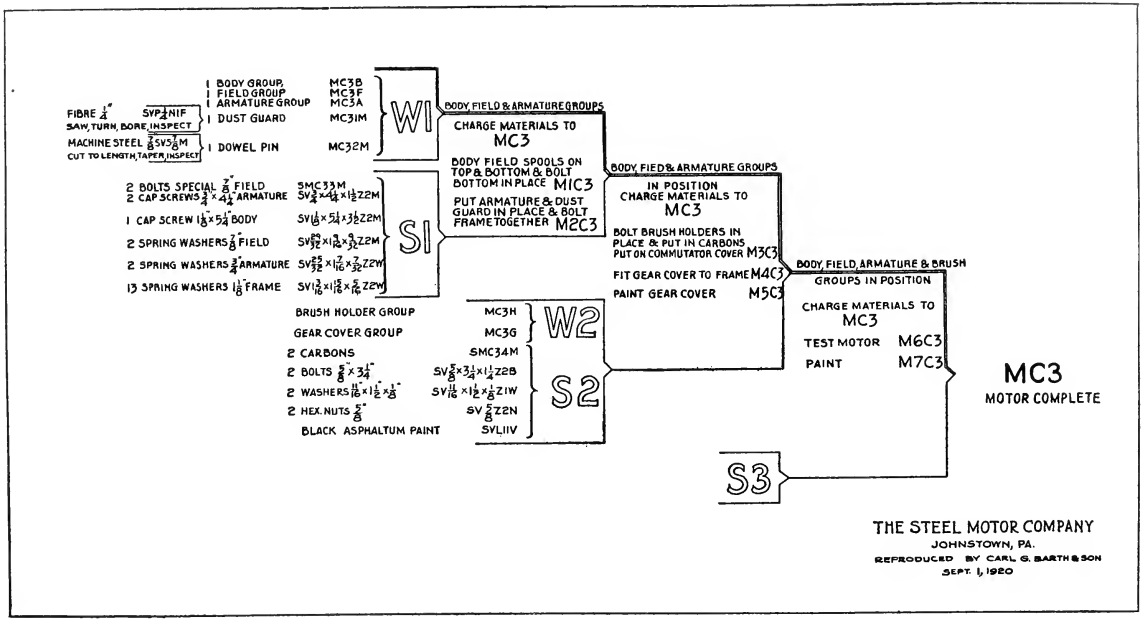

FIG. 76. EARLIEST EXAMPLE OF TAYLOR ROUTE CHART (1896)

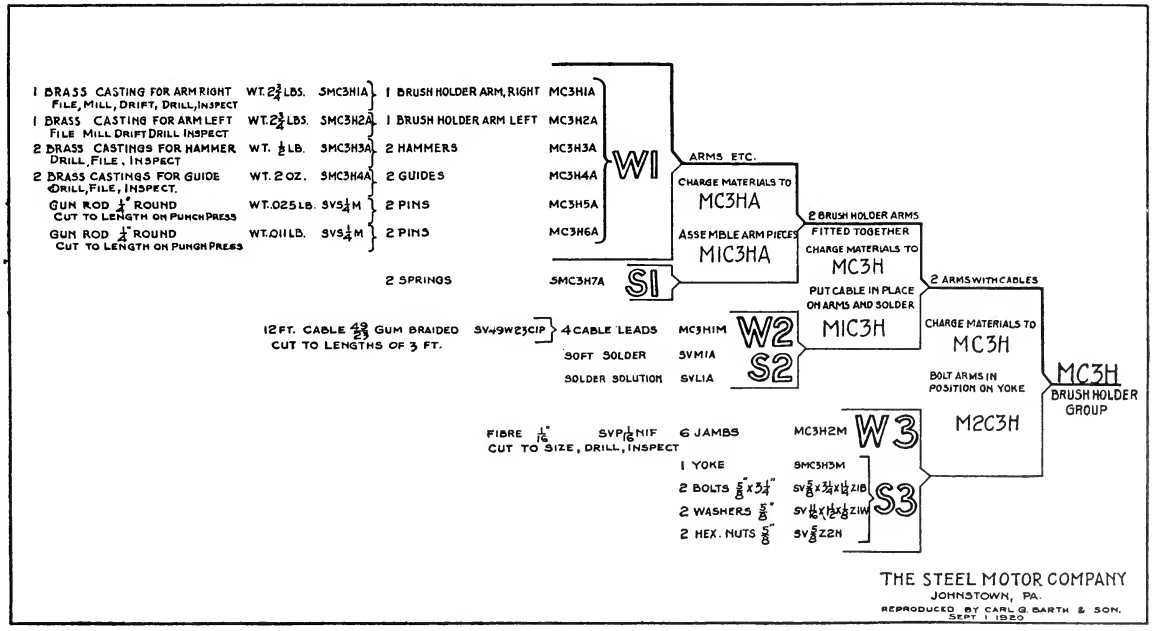

FIG. 77. EARLIEST EXAMPLE OF TAYLOR ROUTE CHART (1896)

division, consisting of parts (not assembled) which are attached as a result of Operations M1C3H and M2C3H.

On the chart for final assembling it will be seen that there are four other groups, MC3A, MC3B, MC3F and MC3G, in addition to the brush-holder group. For each of these groups there is a chart, as in the case of MC3H, while on the final chart they appear as single manufactured units. M1C3, M2C3, etc. show that the operation number was placed after the first letter instead of in front of the symbol, as we should now write it. The present practice is so logical and its advantages are so obvious as to make us wonder that anything different should have been done.

The brush-holder group, MC3H, in Figure 77, consists of only one independent assembled unit. From the foregoing it will be seen that routing serves as the essential basis for all other functions having to do with planning and control of work.

Material Control. A job having been routed, the next step is to see that materials are on hand or will be when wanted.

There may be special materials that are not carried as stock in the store room. If so, the manufacturing order and the route sheets are passed to a clerk whose duty it is to order such material. In some businesses there may be so much of this as to require the full time of one person. In others, the procurement of special materials may be made a duty of a person filling one of the other functions. If speed is essential, special materials may be ordered as the routing of a job progresses or even in the design stage, before work is started. There is, however, less chance of error if this is not done until the work of routing has been completed.

The Balance-of-Stores Clerks. It is the practice under scientific management to keep in the planning department "balance sheets," or running inventory sheets, showing for each article carried in stock, whether purchased or manufactured (see Figure 65): (1) the quantity on hand, that is, actually in stores; (2) the quantity on order but not yet received in stores; (3) the quantity required for orders, for shipment, or manufacture, to which articles have been apportioned but not yet issued; (4) the quantity available for future requirements. This information is constantly needed in connection with planning of work.

As previously stated, orders on the store room (stores and worked-material issues) are made out for all of the various materials or stock parts, as soon as the route clerk has determined what is needed from the drawings and bills of material and has shown this on the route charts and sheets. For articles from stock orders on the store room are made up immediately upon receipt of the customers' shipping orders.

It is the balance clerk's duty to apportion in advance the materials

called for on these issues, and to subtract them from the quantities available. After having drawn down his balance available, he compares it with his minimum quantity shown at the top of the sheet. If the balance available is in excess of the minimum quantity, that ends the transaction; but if it is less than the minimum, he must issue an order for the quantity necessary to replenish it. This he does, in the case of purchased articles, by a requisition on the purchasing agent, or, in the case of worked materials, by issuing a manufacturing order. The quantity to be ordered is shown at the head of the balance sheet.

When an order has been issued for the replenishment of stock, the balance clerk enters the quantity in the column showing materials ordered, adds it to the previous balance, and also to the quantity available.

The minimum quantity is so set that materials will be received before the quantity in stores is exhausted, and hence they may be considered available as soon as ordered. Therefore, the balance ordered, plus the quantity on hand, minus the quantity apportioned, equals the quantity available. Likewise the sum of the balance ordered and the balance on hand, as shown in their respective columns, should equal the sum of the balance available and the quantity apportioned. This is a check on the accuracy of the entries.

In arriving at the proper minimum quantity for each article, the length of time it takes to get the articles and the rate of consumption must be taken into account.

The fixing of these minimum quantities properly in the first place, and the revision of them to meet changes in conditions, are very important. Changes should not be made without the approval of some one competent to judge the advisability of the change. It should be the balance clerk's aim to keep his stock as low as is consistent with economical purchasing, and at the same time to avoid not having materials on hand when wanted. In cases where industries are receiving orders faster than they can be produced, care must be exercised in releasing requisitions for the purchase of materials. Otherwise the investment in stock will become excessive. He must also keep the designing department and the route clerk advised as to any materials on hand for which the demand seems to have ceased, so that they may be used up if possible. He should be consulted frequently by these parties so that they may avoid calling for materials that are not regularly carried in stock, when something equally suitable is on hand.

In the event of materials not being available at the time of apportionment, the balance clerk notifies the proper person in the planning department (the recording clerk) when these materials have been

received in order that the work in connection with which they are to be used may be started.

Each day the store room sends to the balance clerk the stores issues for materials that have been taken out of stores. These he sorts into piles, so that their arrangement is the same as that of the balance sheets in his files.

After he has sorted his issues he enters the quantity in the column for materials issued from stores and subtracts this from the balance previously on hand. He also enters the quantity in the column showing materials apportioned, subtracts it from the balance shown there, and checks off the entry made at the time the materials were apportioned. The total, or balance, in this column should be the sum of the unchecked items.

Reference to the illustration shown in Figure 65 will show that provision is made for subtracting the quantity required from the balance on hand before the materials are actually withdrawn. Later, merely a vertical check mark is drawn and the date entered to indicate completion of the transaction. The purpose of this is to avoid sending the issue slip to the store room when there are insufficient materials on hand. This advance subtraction, known as "assignment" of materials, should, of course, be made only a short time before the material in question is desired, while apportionment should be made, within reason, as far in advance as possible.

The balance sheets should provide for carrying money value, as well as quantities, in the "on hand" column. They thus serve as the supporting detail for the material account in the general ledger. They are furthermore devised to keep separate, with its own cost, each lot received in stores. Issues are made against only one lot at a time, and are charged out at the actual unit cost of that lot. When all of a lot has been issued, the quantity balance and the money value should both show zero. Any error that may have been made is thus brought to light and corrected within a reasonable time. At this time the next lot should be transferred from the column headed "completed lots" to the issuing column.

There are some exceptions to the rule of apportionment in advance, when things are to be secured from stores immediately after the issue is written. In such cases the quantity issued must be subtracted from the quantity available. In the case of most office supplies, and some shop supplies, it is the rule not to apportion materials. Only the columns for materials on hand and materials ordered are used in these instances.

Upon receipt of materials in stores the storekeeper notifies the balance clerk on forms provided for the purpose. Entries are then made

in the columns showing materials ordered and materials on hand. The quantity received is subtracted from the balance ordered and added to the balance on hand.

The balance clerk is responsible for keeping the production clerk advised as to stock parts that are running low, and for the accuracy of his sheets. In this connection he must devote a certain amount of time each day to checking up his balances with the quantities shown on the bin tags and the quantities actually in the bins.

The unique features of this element of the system are: the stores balance sheets are kept in the planning department instead of in the store room, as is customary under the old style of management; apportionment is in advance and the quantity needed is subtracted from the quantity available before items are actually issued; orders for the replenishment of stock are made when the quantity thus shown to be available for future orders falls to the established minimum, rather than when the quantity actually in stock is drawn down to a minimum without regard to requirements for other orders under way in the shop, which have not been called for but which may be called for at any minute. The value of apportionment in advance (as a preventive of awkward and costly delays) will be obvious to the reader.

As a result of keeping the actual cost values, as well as the quantities, of the articles on the balance sheets, these sheets become the "detailed ledger" accounts for the various classes of purchased and manufactured materials. They support the general ledger accounts in the same manner that the individual customers' accounts support and make up, in the aggregate, the general ledger account known as "accounts receivable." In this, as in other ways, the system, or mechanism, of planning and control is made to serve the purposes of accounting also.

Instruction Cards. The methods supervisor as he has been called in the past, "the instruction card man," will next receive the manufacturing order and route sheets, and will prepare an instruction or method card for each separate operation, to show in detail, and step by step, just how the operation is to be performed and what tools are to be used in doing it. This, as stated in the discussion of the routing function, is in reality an extension of routing. Obviously the man filling this function, like the routing supervisor, must be a practical shop man. He should also have engineering training, preferably in the application of engineering principles to production.

The ordinary procedure is for him to describe the operation from start to finish, just as he would perform it at the machine or work place, on his instruction or method cards. After he has done this, he, or a trained clerical assistant, fills in the time for each of the ele-

mentary operations or steps that are comprised in the operation being planned. (See Figure 35 used in Chapter XV, page 219, and referred to in Chapter VII.) The time for the various elements is taken from tabulated data which are the result of elementary time studies of the use of machinery, tools and materials employed in industry.[1]

Obviously an instruction card may take several forms. In non-repetitive industries it is generally possible to classify work according to the operations performed. The same operations are performed in turning a solid gear blank as are performed in turning a spacing collar, or a roller, or a bushing. Different tools may be used, and the relative machining times may differ, but the operations of turning, facing, and boring, etc., remain the same.

The time for the elementary operations, together with certain added allowances, gives the time in which the operation should be done. If there is any question as to which of two methods is the quicker, a rough draft of each should be made up for purposes of comparison. The "instruction card" serves a dual purpose: first, that of defining the method and establishing it as standard, and second, that of determining the time required for the performance of each operation.

Generally a tool list (see Figure 78) is made up at the same time as the instruction card in machine-shop work, where a great many different jobs, each requiring its own peculiar set or combination of tools, may be worked on by each machine.

The Order-of-Work Function. In a small planning department this function may be administered by one man, the production supervisor, with possibly a single minor assistant.

It logically breaks down, however, into three subfunctions to each of which one or more persons may be assigned.

1. *The Planning-Department Order of Work.* This includes everything up to the starting of work in the shop. The main object of this subfunction is to see that shipping orders and manufacturing orders are handled expeditiously through the various stages of design and planning.

The importance of avoiding delay in these activities cannot be overemphasized.

2. *The Shop Order of Work.* This controls the performance of all work in the shop and is responsible for the completion of each job, or manufacturing order, in accordance with the dates set by the production supervisor. This involves: (1) seeing that, so far as pos-

[1] See article by the writer entitled, "Elementary Time Study as a Part of the Taylor System of Scientific Management," *Industrial Engineering*, Vol. XI, No. 2, February, 1912. Also paper on "Standards," *Bulletin of Taylor Society*, Vol. XII, Nos. 5 and 6, October and December, 1927.

sible, ample work is kept ahead of each machine so that there may be a minimum of idle machine time; (2) transferring operators from

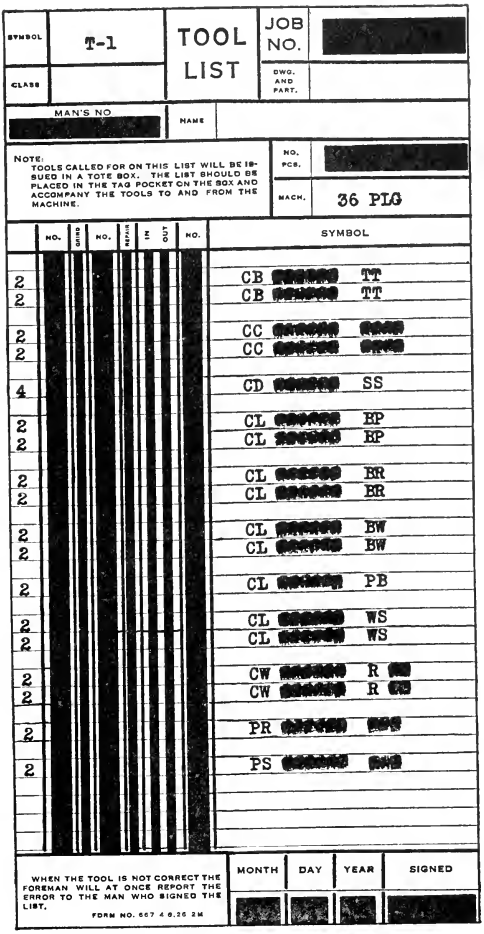
SYMBOL T-1 TOOL LIST JOB NO. [redacted]
CLASS DWG. AND PART.
MAN'S NO [redacted] NAME
NOTE: TOOLS CALLED FOR ON THIS LIST WILL BE ISSUED IN A TOTE BOX. THE LIST SHOULD BE PLACED IN THE TAG POCKET ON THE BOX AND ACCOMPANY THE TOOLS TO AND FROM THE MACHINE.
NO. PCS. [redacted]
MACH. 36 PLG
NO. | GRIND | NO. | REPAIR | IN | OUT | NO. | SYMBOL
2 2 CB [redacted] TT
2 2 CC [redacted]
4 CD [redacted] SS
2 2 CL [redacted] BP
2 2 CL [redacted] BR
2 2 CL [redacted] BW
2 CL [redacted] PB
2 2 CL [redacted] WS
2 2 CW [redacted] R
2 PR [redacted]
2 PS [redacted]
WHEN THE TOOL IS NOT CORRECT THE FOREMAN WILL AT ONCE REPORT THE ERROR TO THE MAN WHO SIGNED THE LIST.
FORM NO. 667 4.6.26 2M
MONTH | DAY | YEAR | SIGNED [redacted]

FIG. 78. TOOL LIST FOR A PARTICULAR OPERATION

machines or work places for which work may not be available to others that have work ahead waiting to be done, or from lesser to more im-

portant work; (3) arranging, as far in advance as possible, for increasing or decreasing the force of employees in accordance with fluctuations in the volume of business; (4) arranging for running equipment overtime or for having certain work done in other shops if the demand exceeds plant capacity at certain points; (5) arranging for prompt correction of anything that may go wrong with work in progress, such as damaged materials, spoiled work, breakdown of equipment, etc.

In short, the shop order-of-work supervisor is responsible to the production supervisor for the completion of orders on scheduled time, and for the fullest and most economical utilization of plant equipment and of the working force.

3. *The Recording Clerk.* He is in a sense an assistant to the shop order-of-work supervisor. He checks the route sheets to show progress from operation to operation, issues job time cards, operation orders, inspection orders, move orders, etc., and does all the mechanical work involved.

To facilitate execution of the work planned, as has been described, the production supervisor and his lieutenant, the shop order-of-work supervisor, have: (1) the route sheets, with their accompanying papers, for each operation on the work to be performed; (2) a planning-department bulletin board (sometimes referred to as a "dispatching board" or "order-of-work board"). (See Figure 79.[1]) As work progresses on each manufacturing order it is recorded on the route sheet, and hence the exact status of any order at any time may be readily ascertained. The manner in which the route sheets are used will be described in detail further on.

The bulletin board not only serves as a part of the machinery by which the progress of work is controlled, but it discloses at a glance, in the case of each machine, work place, or other producing unit: (1) whether or not it is in operation, and if it is in operation,

[1] For each machine or work place in the shop there are three pairs of hooks. The first hooks hold the operation order for the job in progress, stamped with the time started; under this order is hung a slip or tag giving the name of the operator and showing the machines he is qualified to run or the classes of work he can do. If the machine is idle a slip of distinctive color and wording showing the reason, such as, "No operator," "Operator absent," "Machine under repair," is placed on the first hooks. The second hooks hold the planning department copies of operation orders for jobs ready to be done—for which the materials have been moved to the machine or work place, or into an adjacent storage place or truck station serving a group. The third hooks hold operation orders for jobs ahead but not ready to be done, i.e., having preceding operations yet to be performed or waiting for materials to be issued.

Another form of bulletin board has pockets or compartments taking the place of hooks. Both are developments of Mr. Taylor and Mr. Barth. The writer favors the hook board as he believes it a little handier to operate. It also serves to make shop conditions visible.

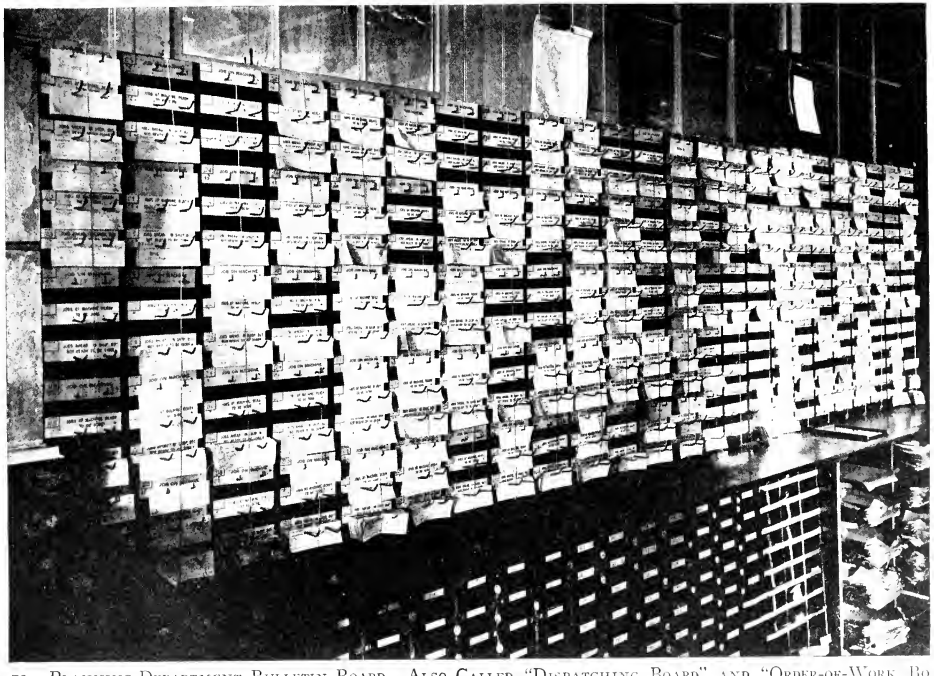

FIG. 79. PLANNING-DEPARTMENT BULLETIN BOARD. ALSO CALLED "DISPATCHING BOARD" AND "ORDER-OF-WORK BOARD"

what job is being worked on and who is doing it; (2) what jobs are ahead of the machine or work place, and ready to be done; (3) what jobs are ahead of the machine or work place, but not ready to be done. As each job is represented by an operation order, which shows the time its performance should take, the number of hours' work ahead of each machine may readily be ascertained. A description of the manner in which the shop order-of-work supervisor utilizes the planning-department bulletin board follows:

He must see that the various jobs (operation orders) ahead of each machine are taken up and performed in accordance with their relative importance, deciding, as each new job arrives at a machine, whether it is to be done next after the job under way, or whether it is to be the third, fourth or fifth job. In deciding this he is guided by the order of work, or schedule, furnished him by the production supervisor.

Where there is not enough work to keep certain machines running steadily, he decides when to transfer men to them as work accumulates. To do this intelligently, he must know what kind of machines each workman can operate, and the grades of work each is capable of doing. This information he must secure from the various foremen and inspectors. Usually this is recorded on a tag, which is hung on the bulletin board under the machine at which he is working.

It is his duty to see that each man has laid out ahead of him at all times a proper amount of work (usually enough for at least ten hours), and to notify the proper person in case he cannot get work enough for the men, or in case there are not enough men to complete the work when due.

The bulletin board referred to is a most important piece of planning department machinery, of which there are a number of forms. A description of one of these forms will, however, suffice, as the differences are merely of construction and not of principle.

On the bulletin board under discussion there is a set of three hooks, one under the other, for each machine or work place in the shop. On the first of the hooks is hung the operation order for the job in progress on the machine, and a tag showing the name of the workman on the machine. On the second hook are the operation orders for the various jobs that are at the machine waiting to be done. These are arranged in the order in which they are to be taken up by the operator. Duplicates of these orders are also shown on a bulletin board in the shop, placed in a location convenient to the machines, to which the preparation supervisor and the workmen refer for information concerning their work. On the third hook are hung the operation orders for jobs in progress in the shop, which are to be worked on by the machine, but which have not yet progressed to the machine

in question. That is, they are at some other machine where operations are being performed that precede the one represented by the order on the third hook.

From this it will be seen that the order-of-work supervisor has a "bird's-eye view" of what is going on in the shop, what work is ahead of each machine, and that he is able to plan the work much more intelligently than can the foreman, under the old style of management, who depended upon his memory and upon observation for keeping track of and laying out his work. Any one who has worked as a foreman under the old style of management will realize how difficult it is to keep a gang of men supplied with work, and to be sure that each man is working on the job that is of the greatest importance.

The order-of-work clerk is constantly and systematically going over the bulletin board to see which machines (with men working on them) are running short of work; which machines with work ahead that should be started have no men assigned to them; what men will be available because all the work ahead of them is finished, and how soon; that an important job is not waiting while one that is less important is being worked on, etc.

Lost time between the completion of one job and the starting of the next is thus avoided. It is a rule to have preparations made in advance for two or more jobs (at least ten hours work) for each workman. If the order-of-work clerk finds that there is less than this amount of work ahead of a workman on the machine he is operating at the time, he first sees whether there is any more work that can be got to the machine in question in time to keep it going. If not, he next ascertains to what other machine, idle at the time, but at which there is work waiting to be done, the workman may be most advantageously transferred. He then arranges to transfer him, and indicates this by a notification slip, similar to an operation order, on the hooks for the machines from which he is to be transferred and to which he is assigned. Duplicates of these slips are of course placed on the shop bulletin boards for the guidance of the workman and the preparation and method supervisors.

The bulletin board is also used as a guide in sending out drawings, instruction cards and tool lists to the machines in advance of the time at which jobs are to be started, so that preparation may be made for each job. When a workman finishes his last job on a given machine, or is for any reason transferred to another, and goes to the machine to which he has been assigned, he will find everything ready for him to start work without loss of time. His drawing, instruction card, etc., have been delivered and his tools procured from the tool room. The use of the bulletin board is closely linked up with the use of the route

sheets. In fact, one without the other would be practically useless, as will be seen from the following.

Let us assume that the work covered by a manufacturing order has been planned as described; that the route sheet, or sheets, together with their accompanying papers have been placed in the active route files and turned over to the shop order-of-work supervisor, and that the requirements are such that the job should at once be started out in the shop. This would, of course, normally be the case. After seeing that the order is shown on his order-of-work or production schedule in a position that accords with its relative importance, he proceeds as follows with each route sheet: he sends the stores issue to the balance-of-stores clerk for assignment of material, that is, for deduction (if the material is shown to be on hand) from the quantity in stock. If it is returned showing no unassigned material on hand, he places it in a file with any other issues for jobs held up pending receipt of materials and reports the shortage to the production supervisor, in order that appropriate measures may be taken to expedite the delivery of material on order.

If, as should usually be the case, the materials are on hand, the next step is to check the route sheet in the vertical checking spaces on the line reading "materials in stores." (For the sake of conformity, it is the practice to draw the check marks in all four spaces shown in the illustration—Figure 61. The check marks on the line reading "material ordered" are of course made earlier, during the order's progress through the planning department.) Next, the move order for moving the material from the store room to the machine where the first operation is to be performed is removed from the envelope, and a half check mark drawn on the line representing the operation under the heading "move." This indicates that the material is ordered moved or, to be strictly accurate, that steps have been taken to that end. In due course the move order, together with the stores issue, will be handed to a move man at the planning department window. A laborer whose sole work is to move material from place to place as directed by the planning department through the move orders will secure the material and deliver it. In some cases the practice is to send the stores issues to the store room, and to hold the move order until the material has been made ready for delivery and the stores issues sent back to the planning department. Another refinement is to treat the preparation of stores for issue as a first operation, and to use an operation order and time card. In either of these variations the object is to control the work of getting out stores and to conserve the time of the move men. Which one of the three methods to use should be decided when the job is routed. It depends upon its nature,

the conditions in the plant, and the exercise of common sense. One method only may be suited to all work done, or all three may be employed in the same plant. The operation orders (both planning-department and shop copies) are placed on the third hooks, for the machines in question, on the planning-department bulletin board, which contains jobs ahead for which materials are in the shop but which are not yet ready to be done. If there are several operations, the operation orders for each are placed on the third hooks for the respective machines indicated on the route sheet.

When the move man has delivered the materials he returns the move order to the planning department window and is given another. The next step is to complete the half check mark on the route sheet in the move column and draw a half check mark under the heading "operation," to indicate that the operation has been ordered done. The operation order must be removed from the third hooks and the planning-department copy placed on the second hooks in the order of its importance, or urgency, in relation to other jobs ahead of the machine, as shown by the order of work. The shop copy is placed in a corresponding position on the shop bulletin board, to which the gang boss and the workmen refer.

When the workman has finished the job which preceded the one we are considering, he turns in his time card at the planning-department window. The time card and inspection ticket for the job he is about to start are then taken from the pocket or envelope and a half check mark is drawn opposite the operation, under the heading "first inspection." This indicates that the job is in progress and is a notification to the inspector. The time card is stamped with the date and time that the operation was started and handed to the workman. Previous to this—while he had two or three jobs ahead—the drawing, tool list, and instruction card were delivered from the planning department to the workman; the gang boss had the tools procured from the tool room and checked up the materials to see that they were properly placed. The inspection ticket is stamped and sent, with any others that may be ready, to the inspector as his notification that the job is being started, so that he may see that the workman understands the drawing, give him any needed instruction with reference to quality, and see that the first piece is correctly made. The planning department copy of the operation order is stamped to show the starting time the same as that on the time card, and is then placed on the bulletin board on the first hooks for the machine in question, to show that the job is in progress on the machine.

When the inspection order is returned, after the inspector has seen that the job is properly started, it is returned to the envelope, where

it remains until the job is finished and the check mark on the route sheet under the heading "first inspection" is completed. This shows that the job is in progress and that the inspector has satisfied himself, so far as quality is concerned, that everything is satisfactory. (In some plants it is found desirable to have the inspector retain the inspection order until the job is finished. It is unwise, however, to do this during the early stages of the system's development.)

When the job is finished the workman returns his time card to the planning department and it is stamped with the time finished. The check mark on the route sheet under the heading "operation is completed," and a half check mark drawn under the heading "final inspection," indicate that the job is finished and awaiting inspection. The inspection order is stamped with the time and sent out to the inspector for a report of his findings regarding the entire lot. (It is obviously good practice for the inspector to follow up the job during its progress. He should inspect the work done at intervals rather than wait and inspect the entire lot upon its completion.)

Upon the return of the inspection order it is stamped with the time returned. The check mark under the heading "final inspection" on the route sheet is completed and a half check mark under the heading "move" is drawn on the next line to show that the materials have been ordered moved to the machine that is to perform the next operation or, in the case of the last operation, to its final destination, which is the store room. If it is one of several parts to be assembled with others the half check mark indicates the point at which assembling is to take place. In the latter case, delivery would be recorded on the appropriate assembling route sheet. If there are a number of operations called for on the route sheet, the cycle described is completed in the case of each.

In discussing the routing of a simple article consisting of several parts which, after being completed, are to be assembled, a valve for a molding machine was taken as an example and reference made to the use of the assembling route sheet. (See Figure 64.) For the final assembling of a machine or other product, for each major subdivision or group, and for each further subdivision thereof previously designated as a division, there would be an assembling route sheet. These not only provide for recording the performance of the various assembling operations involved, but they show at the top the component parts—whether drawn from stores or manufactured especially for the order—that must be on hand before the order is issued for performing the assembling operations in which these parts are involved.

By referring back to the foregoing description and keeping in mind that, as each part is finished, that fact is entered on the assembling

route sheet to which it pertains, I am sure that the reader will obtain a clear understanding of the use of assembling route sheets. Not only are the individual parts so treated but, as the assembling of a division is completed, that fact is recorded on the assembling route sheet for the group to which it belongs. When a group has been assembled the final assembling route sheet is checked to show that it is ready to be assembled with the others entering into the complete product.

There are, of course, many modifications and variations in the methods and mechanisms that I have described. These are possible and necessary to meet the needs of different businesses. It may be a slight exaggeration to say that in no two instances may identical methods and mechanisms be applied, but it is not far from the truth. It is in making such adaptations and modifications and in devising new means to meet new conditions that the skill of even the most experienced industrial engineer is taxed, and most needed.

Planning-Department Organization. The question is frequently asked: What relation should the number of men in the planning department bear to the total number of workmen? The answer to this is that it depends entirely upon the size and nature of each specific business. In some cases two or more men are required for each of the positions enumerated, while in others two or more of the positions may be combined. For example, one well-known concern has a shop employing about four hundred workmen, with a planning department composed of only four men, while another, employing about one hundred in its shops, requires a planning force of twenty people. The reason for this is that the first concern manufactures, in its shop, a limited variety of products in large quantities, with infrequent changes in design. In most cases each machine runs for months, or at least weeks, on the same job. The second concern, on the other hand, manufactures a great variety of products in comparatively small quantities. Much of their product is special and subject to frequent changes in design. In the second concern, each workman works on the average on four different jobs per day.

The principal or major functional foremen in the planning department as indicated by the description of their activities are: (1) the production supervisor, (2) the route man, (3) the methods supervisor, (4) the balance-of-stores clerk. All other planning-department personnel is engaged in activities which may be regarded as subfunctions, or auxiliary to these.

For example, the production supervisor may have two principal assistants: the planning-department order-of-work supervisor and the shop order-of-work supervisor. The methods supervisor may have under his direction one or more time-study men and assistants spe-

cializing in the preparation of instruction cards for classes of work in which each is particularly proficient. In addition to these there may be especially trained stenographers and clerks on his staff.

Just as the detailed mechanisms must be devised to suit the particular case, so must the organization be designed to fit.

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PART V

CONTROL

2. The Maintenance of Standards

Never suffer an exception to occur till the new habit is securely rooted in your life. Each lapse is like the letting fall of a ball of string which one is carefully winding up; a single slip undoes more than a great many turns will wind again.—WILLIAM JAMES.

The lives of men in any class are more affected by the habits which they form than by any other one influence. It is my observation that good principles usually follow good habits, instead of the reverse. The best way to secure good principles in men, therefore, is to firmly establish them in good habits. . . . The moral effect of this habit of doing things according to law and method is great. It develops men of principle in other directions. When men spend the greater part of their active working hours in regulating their every movement in accordance with clear-cut formulated laws, they form habits which inevitably affect and in many cases control them in their family life, and in all of their acts outside of working hours. With almost certainty they begin to guide the rest of their lives according to principles and laws. —FREDERICK W. TAYLOR.

CHAPTER XXIII

INSPECTION OF PHYSICAL STANDARDS[1]

THE maintenance of standards, previously agreed upon and established, through continuous inspection of plant, equipment, materials, processes, products and performance was one of the first functions to be recognized by Taylor in the development of his methods and has become an established procedure of scientific management. There is here involved, in fact, the maintenance of quality; concerned as pertaining to means as well as to end result. Quality as here used does not imply a higher as contrasted to a lower grade of equipment, material or product. It means the maintenance of every factor and result of effort *at the grade determined to be standard* in the particular situation. If a Ford truck is discovered by experiment to be the most suitable truck—as to service and economy—for one type of hauling, and a Pierce Arrow to be most suitable for another type of hauling, each is adopted as standard for its particular service. The matter of quality then becomes one of maintaining each at the highest point of efficiency of which it is capable.

A standard is neither established nor maintained by the simple process of publishing the specifications which define it. Because individuals vary in their capacities to understand specifications and to acquire new patterns of habit, continuous inspection of efforts, as manifested in means, methods and results, and explanation and correction of errors, are essential to that educational process which constitutes the establishment of standards. Also, individuals vary in their capacities to maintain standards—whether it be the New Year's resolution, the periodic oiling and greasing of an automobile, the perfect edge on a cutting tool or a method of manipulation. This makes necessary a system of continuous reminders, especially when, as under division of labor, the effectiveness of one worker's performance is dependent upon the maintenance of qualities in other workers' performances. These reminders are based upon facts revealed by a continuous inspection of facilities and performances. This chapter is concerned only with the inspection of physical facilities.

There appears to be a popular belief that inspection—particularly of product and of performance—is essential chiefly to counteract the impulse toward quantity output regardless of quality, generated in workers by a piece rate or other form of differential wage payment.

[1] By H. S. Person, Managing Director of the Taylor Society, New York.

Its necessity in this respect cannot be questioned. But it should be observed that the utility of inspection on this account does not make it a basic element of scientific management as distinguished from any other type of management. The differential system of wage payment is not an essential factor in scientific management; it has an origin independent of scientific management in the management movement described in Chapter I. Whenever in particular instances scientific management has appropriated the device of a differential wage system—which is in the majority of instances—it has on that account perceived this reason for inspection. But there is another reason for inspection which is peculiar to and basic in scientific management.

The reason for inspection which is peculiar to scientific management is that it serves as a device for the maintenance of, or interpretation of reasons for variation from—the definite standards which have been established, the constants in terms of which all calculations concerning times of performance, order of work, costs and other factors are computed. If scientific management is a management of precision made possible by the substitution of constants for variables, then the maintenance of the constants is essential. Inspection promotes this maintenance of constants; and if, notwithstanding inspection, certain constants cannot be maintained, inspection discovers the exact situation, the causes and the consequences.

In a certain illustrative instance the output of three identical machines was discovered to be falling off and upsetting the flow of work. Special investigation disclosed that one of the machines was producing less than half and a second less than three-fourths its estimated capacity. Further inspection disclosed that the cause was slipping belts. When the proper belting tensions had been restored, calculated output was again realized. Periodic inspection would have avoided, and subsequent periodic inspection did avoid, these variations from calculations. In another instance the output of a worker assembling small machines was increased sixfold by reorganization of his conditions and methods of work. This was the gross, not the net gain, for the gain was achieved in part by the addition of inspector assistants and tote men. A substantial part of the net gain was secured by the institution of parts inspection which permitted only parts which would fit to come to the assembly bench, thereby relieving the assembly operation of much filing and hand fitting. It is as a procedure of coordinating specialized operations and eliminating much scrap not possible of recovery that continuous inspection assumes so important a place in the procedures of scientific management.

Plant and Equipment. The inspection and maintenance of buildings, conveying apparatus, machines, tools, dies and other physi-

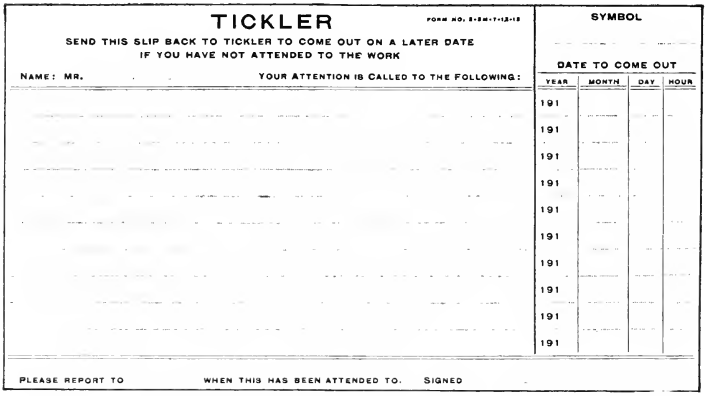
cal facilities which are not consumable and deteriorate only gradually is provided for in a common manner; by periodic examination, replacement of parts, adjusting, oiling, painting, and so on. The essential factors in such inspection and maintenance are assignment of responsibility; predetermined periodicity of inspection, which periodicity will vary with each class of facilities involved; and automatic reminders of the arrival of a period of inspection. Generally the responsibility rests on an engineering or maintenance unit, and within the unit, specialists will be responsible for particular classes of facilities; electricians for generators and dynamos, mechanical engineers for machines, and a foreman selected from among expert tool makers for tools and dies. In the case of highly specialized equipment, such as elevators, conveyors, and calculating machines, experts are sent in periodically by the manufacturer.

The periodicity of inspection is determined by careful investigation of each facility. Even such homely matters as painting may be scheduled for intervals fitting the particular structure and its use; for instance, interior steel members of the building every five years, exposed steel members every two years, and interior walls, because of the important part they play in the reflection of light, annually. Machines may be scheduled for superficial inspection, adjustment and oiling daily, and for detailed inspection and replacement of parts at longer intervals.

Of one group of cotton mills it is reported that "when the mill is in proper condition for operating, definite schedules of maintenance inspection are formulated with the purpose of obviating interruptions to continuous processing through impairment of equipment. There are definite schedules and a system of planning-room control for such things as painting, oiling, cleaning, overhauling, belting wear and tension and renewals. At scheduled intervals each machine is taken down, inspected and adjusted in every part even though periodic inspection may not have discovered signs of deterioration. Maintenance is scheduled by four-week periods for several years in advance—whether it involves the triennial painting of the mill, the annual taking down of a motor, or the periodic relining of a spinning frame—and a maintenance budget is constructed which through a standard burden rate distributes the costs of the long period evenly over the successive four-week periods. As a consequence of these maintenance control methods, a mill operates continuously with a minimum of breakdown, and maintenance is effected more precisely and economically than would be possible if attended to after breakdowns." [1] Of course, although

[1] Kendall, Henry P., "Scientific Management in a Textile Business," *Bulletin of the Taylor Society*, Vol. XII, No. 6, December, 1927, p. 523.

such schedules of inspection are "definite," that does not mean that they are not revised as experience and experiment disclose reasons for revision. In a plant manufacturing typewriters: "Upon the completion of an operation all tools, together with from fifteen to twenty-five of the last parts made by each tool and a tool service slip giving the number of parts made and commenting on the condition of the tool, are sent to the tool-inspection section. A careful inspection is made and if any defects are found the tool is immediately sent to the tool room to be conditioned. Upon completion of the conditioning of the tool it is returned to the tool-inspection section, is again inspected, and if approved is placed in its proper location in the tool crib with the last parts made and is ready for use." [1]


TICKLER

FORM NO. 2-2M-7-12-13

SEND THIS SLIP BACK TO TICKLER TO COME OUT ON A LATER DATE IF YOU HAVE NOT ATTENDED TO THE WORK

NAME: MR. YOUR ATTENTION IS CALLED TO THE FOLLOWING:

SYMBOL

DATE TO COME OUT

YEAR	MONTH	DAY	HOUR
191			
191			
191			
191			
191			
191			
191			
191			
191			
191			

PLEASE REPORT TO WHEN THIS HAS BEEN ATTENDED TO. SIGNED

FIG. 80. A TICKLER STRIP WITH PROVISION (AT RIGHT) FOR RECURRENT USE

The device most used in Taylor practice to remind inspectors that an inspection period has arrived is the tickler—an automatic reminder. A tickler is simply a section of the files which has two sets of guide cards, one set for months, and the other for days of the month. A memorandum pertaining to each scheduled inspection is filed in the appropriate location in this file, and each day the memoranda for that day are removed by a clerk and distributed among the inspectors concerned. A typical inspection memorandum is shown in Figure 80.

It is obvious that the tickler system can be used for other reminders than these pertaining to inspection; for instance, by executives for conferences and other obligations. It is desirable to note that con-

[1] Brown, Percy S., "The Organization and Management of a Medium-Sized Plant," *Bulletin of the Taylor Society*, Vol. VIII, No. 1, February, 1923, p. 16.

siderable attention has to be given to the educational process of getting the tickler used generally, but also that such attention is well repaid in ultimate results.

Materials and Products. The inspection of materials, supplies, worked materials, and completed product is identical in principle with the inspection of equipment. However, in so far as they represent a much greater variety of items the procedures are more varied, and in so far as they are geared into processing, they are simpler. For instance, in this field of inspection the tickler has only moderate use.

1. *Materials and Supplies on Receipt.* These should be purchased on specifications which give detailed characteristics determined by the use requirements of the purchaser, and expressed in terms fully understood by vendor and buyer. In the case of standard branded items, such as a soap, the brand name and number constitute a sufficient specification; but in the case of some raw materials, such as alloy metals, the specifications may be very detailed. Another item may involve specifications falling anywhere between these two extremes. The nature of the inspection may vary accordingly. In the case of a branded item the wrapper or the label and seal of the container may be sufficient evidence of the quality of the lot, the integrity of the vender being relied upon. In the case of raw materials, such as alloy metals, samples of the lot will be given laboratory analysis. In the case of the textile mills referred to above, it is recorded that "Maintenance of uniform quality of raw cotton is of equal importance to the maintenance of perfect condition of equipment. After the most desirable standard of raw cotton has been determined by experiment—the best combination of character, color, staple, and grade—cotton of that quality only is purchased, and expert inspection of all receipts is the basis of a most rigid practice of acceptance or rejection. It is interesting to note that, as soon as standardization, inspection and rejection of cotton below standard become established as fixed practices, delivery of cotton below standard practically ceases."[1] The result is that "With equipment in perfect condition and even running raw material, weavers and spinners are able to tend from two to three times as many looms and spindles as they have been tending before such maintenance control is developed."[2]

2. *Materials and Supplies—in Stores.* Materials and supplies in stores are subject to two principal conditions of variability: deterioration in quality and diminution in quantity. Some items of a chemical nature deteriorate from atmospheric conditions or from the chemical

[1] *Ibid.*, Vol. XII, No. 6, December, 1927, p. 523.
[2] *Ibid.*, p. 524.

interaction of their constituent parts—so called "aging"; others such as leather may deteriorate from conditions of heat and moisture. All diminish in quantity as they are consumed in processing or are discarded because of deterioration in quality, and this diminution in quantity may have serious consequences if workers and equipment are frequently subjected to inactivity because of a shortage of some material. Inspection of materials in stores, both with respect to quality and quantity, becomes therefore an important phase of continuing inspection. Inspection of materials as to quality is practically identical in nature and procedure to the inspection of equipment. Inspection as to quantity is controlled principally through the balance-of-stores ledger in the planning room,[1] but this control should be checked by periodic actual count of physical items, in which case the inspection becomes one not only of the quantity of the items but also of the accuracy of the balance-of-stores ledgers. As a detail of satisfactory practice it has become customary in some plants to conduct such checks whenever the balance-of-stores record on any item shows that the amount on hand has fallen to or below the established minimum. In this way the contingency of running entirely out of stock is avoided, and the correspondence of the actual stores and the stores record is maintained.

3. *Materials in Process.* The inspection of worked and partly worked materials constitutes a simultaneous double inspection—inspection of the quality of the performance of the worker, which will be considered in the next chapter, and of the quality of the part which results from the performance. In this inspection of the physical part an appraisal by the sight or touch of a skilled inspector may be sufficient; in another instance quick measurement by calipers may be required; while in another precise measurement by gauges or the interferometer, and weighing and balancing may be essential. Parts which pass inspection may then proceed to the next passage or to worked-material stores, with the assurance that subsequent operations will not be wasted in work on parts already spoiled, or in attempts to assemble parts which do not fit. Parts which do not pass inspection may proceed to a special conditioning unit, if the defect is remediable, or to the salvage unit.

In some plants special physical laboratories have been constructed, with a complete equipment of the most precise and delicate measuring apparatus, for the purpose of inspection and maintenance of working gauges, tools and similar equipment.

It was in connection with this inspection of materials in process that Taylor early incorporated a very important factor into scientific management technique—the inspection of the first piece of a lot to come

[1] Cf. Chapter XXII.

off a machine in addition to the conventional inspection of the entire lot after processing. This inspection of the first piece of a lot has three principal purposes: to save the waste of material through defective workmanship on an entire lot because of misunderstanding by the worker; to save the waste of labor effort—a saving to the employer in the case of time payments and to the worker in the case of piece rates; and to save the waste of investment in equipment incurred during the period of misapplication of effort. (See Figure 57 used in Chapter XXII, page 328.)

4. *Subassemblies and Final Assemblies.* The inspection of subassemblies and final assemblies constitutes more an inspection of performance than of the physical parts; but it does constitute a final, super-inspection of parts. Particularly through tryouts, as in the case of machines, there may be disclosed after final assembly defects in material, in workmanship or in physical conditions of parts which escaped previous inspections.

It should be repeated that there are two objectives in inspection of physical standards: to avoid deterioration in quality of craftsmanship induced by the workers' desire to achieve quantity under an incentive wage system; and to coordinate the efforts of workers qualitatively under division of labor. Where proper inspection is absent there is much waste resulting from shortages of materials, processing on materials already spoiled in previous processes, or from the necessity of filing and hand fitting in an assembly operation. It should be noted also that inspection is by no means an insignificant item of cost, and *the degree to which a system of inspection should be developed in any particular instance must be determined by investigation and experiment, and the balancing of savings against cost.* In this connection it should be noted, however, that while in the long run inspection must produce more than it costs, at the beginning of the development of new methods of operating it is a good investment to pay any necessary cost for sufficient inspection to assure the complete establishment of the new operation habits. After these habits have become well established, the quantity and costs of inspection may be reduced. Generally thorough inspection repays its cost generously in the savings of misapplied labor and overhead, and of wasted materials, in elimination of idle workers and machines, and through a market prestige resulting from products rated by consumers as dependable and precise deliveries.

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CHAPTER XXIV

INSPECTION OF PERFORMANCE[1]

THE inspection of individual performances is not less important than that inspection of physical factors which has been explained in the preceding chapter. In fact, where human nature is involved there is greater danger of variations from standards than where inanimate nature is involved. While scientific management recognizes general variability in human capacities and attempts to discover differences and assign responsibilities in accordance with capacities, it is not content to leave to chance the suitability of application of human capacity in any particular instance.

A systematic, continuous inspection of the performance of individual executives and operatives has two major objectives: to secure data for rating individual efficiencies, and to discover variations from standard operating conditions which otherwise would not be so promptly detected. Devices for the accomplishment of both of these objectives has had an important part in the procedures of scientific management from its beginning; but in the early period, before the principles had been applied to general administration and to merchandising and selling, attention was focused only on the performance of shop executives and workers' efficiency on individual jobs.

Taylor was a pioneer in the recognition of the importance of differences in individual capacities, and their influence upon management. His basic constructive work was done before the functionalized personnel department and the technique of modern psychology were even conceived. But his experience with time-study measurements, standardized tasks, and differential systems of wage payment promptly focused his attention on the reality of the differences in individual capacities. He called attention to this fact by his analogy of the trotting horse, the family driving horse and the draft horse. He therefore incorporated into his procedures devices for detecting individual differences as a basis for assignment and instruction. In that day, the only available means of appraising individual capacity was by inspection through performance records. In addition to performance records of that sort, his differential piece-rate system was designed to serve also as a selective mechanism.

It is likely that to him even more significant was inspection of performance as a means of detecting deterioration in the standard condi-

[1] By H. S. Person, Managing Director of the Taylor Society, New York.

tions basic to standard performance. Otherwise it is difficult to understand why he insisted on *continuous* inspection. Occasional inspection by a summary of records would have been sufficient for appraisal of individual capacity. The primary reason for continuity of inspection, on the other hand, was to detect carelessness and indifference with respect to standards, and to bring them to the attention of those responsible in time for correction before the flow of work and costs would be in large degree unfavorably affected. Therefore he established a progress record unit which constantly checked returned work order slips against planning room schedules, and any sign of serious lag in the progress of an operation was immediately reported and special inspection promptly made of the conditions at the point of delay. Usually the cause of the delay was found to be some condition for which the operative was not responsible—a slipping belt, an improper tool, defective raw material—conditions which could be at once corrected.

Performance in the Shop. The progress of work through processing and the effectiveness of individual contributions thereto can be much more accurately observed and precisely valued than can any other type of performance. For in the shop, as has been noted, standard conditions can be more firmly established and the area of the unexpected reduced to a minimum. On this basis of such standard conditions there can by time study be constructed standard times for all operations, which will hold good for purposes of planning so long as the conditions remain standard. The sequence and approximate duration of all operations involved in any order or job can be determined by analysis. The planning room can lay out the work on any job in terms of the man hours or machine hours required for its completion, and therefore, having determined when work on the job shall begin, can predict when work on each element of the job and on the entire job should be completed. Continuous checking against its estimated time of the time of each increment of work as it is completed, makes possible a continuous appraisal of individual efficiency and of working conditions. If deterioration in working conditions is indicated, the causes can be instantly determined and corrections made. The records of workers' efficiency on individual jobs go into their general records and permit an over-all or long-time rating of the efficiency of each.

Early in the development of scientific management Taylor incorporated such continuous inspection into the work of the planning room. The documents involved in the procedure are called progress records. As soon as an order or job is put into process a copy of the route sheet, previously prepared by the route clerk, is sent to the progress record clerks. On this sheet (See Figures 62-64 used in

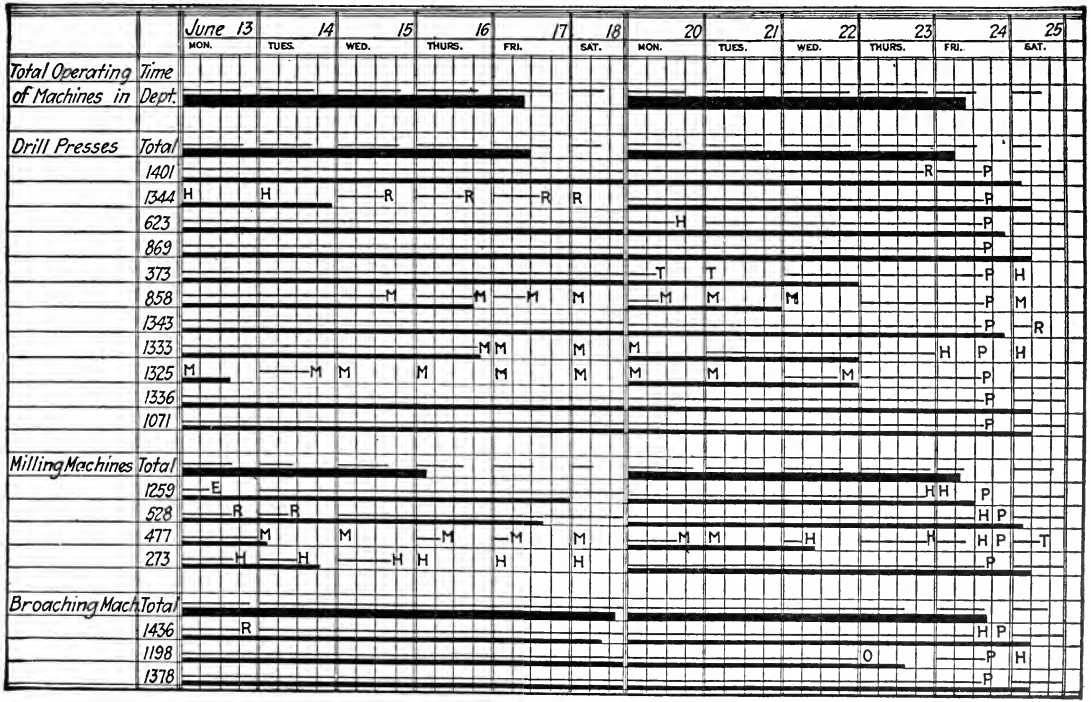

FIG. 81. GANTT MACHINE RECORD CHART

Reproduced by permission from "The Gantt Chart" by Wallace Clark, New York, The Ronald Press Company, 1023, p 24

Chapter XXII, pages 339-341) each main and suboperation is listed and on it are columns for graphical checking of progress. Actual progress is indicated by the work-order slips returned by the worker on the completion of an operation to the order-of-work clerk, and by the latter sent to the progress record clerks. Each work-order slip by symbols identifies the order or job and the operation to which it belongs, and by stampings of the time clock, the time taken to complete the operation. From these work-order slips the progress record clerks make appropriate marks on the route sheet, and the graphical appearance of the route sheet at any time indicates the status of work on the job or order. If any unit operation is observed to be behind schedule, the production supervisor is notified and a special inspection is made of conditions at that work place. If the delay is caused by improper conditions or facilities, they are corrected. If the delay is caused by lack of competence of the operative (as when regular operative is absent and a less skilled worker has taken his place) the operation may be shifted to another machine, or a more skilled worker temporarily assigned to the machine which the work already occupies, or affairs may be left as they are, the not unimportant result of inspection in the latter instance being a knowledge of the facts of the case.

Henry L. Gantt adopted and extended this principle of inspection, in fact, made it the corner stone of his technique of development of scientific management; and for its wider application he devised graphical forms of recording performance to which have been given the name Gantt Charts.[1] One of Gantt's greatest contributions to scientific management was the procedure of using inspection, by means of the information yielded by progress records, as a device for *improving* conditions and methods, through publicity of results and reasons, as well as for maintaining them; whereas Taylor had used it mainly as a device for maintenance of conditions and methods which had been discovered, designed and established chiefly through other procedures. A series of Gantt charts, of which specimens are indicated by Figures 81 [2]

[1] Cf. Clark, Wallace, *The Gantt Chart*, New York, The Ronald Press Company, 1922.

[2] In Figure 81 the vertical spaces represent to scale the days and working hours of the plant. The horizontal lines indicate on this scale the running time of individual machines (light lines), the weekly total of individual machines (heavier), the weekly total of groups of machines (heavier) and the weekly total of all machines in a department (heaviest). The portion of the daily space through which no line is drawn represents the time the machine was idle. The curve of idleness is represented by letters according to the following legend:

E—Waiting for set-up.
H—Lack of help.
M—Lack of material.
O—Lack of orders.
P—Lack of power.
R—Repairs.
T—Lack of Tools.
V—Holiday.

and 82 [1] can be made to record graphically and currently the progress of operations—by operations, machines, groups of machines, shops, and for the entire business.

Still another graphical variant of maintenance and control through inspection of performance is that of the Thompson and Lichtner Company illustrated in Figures 83 and 84.

With respect to all of these devices for inspection of performance it should be observed: first, that they are identical in principle; second, that they differ mainly in graphical symbolization; third, that all are used to check progress on work and control the flow; and fourth, that they may be used to a greater or less extent for purposes of instruction and inducing voluntary improvement of conditions and methods on the part of foremen and workers. As has been noted, it is with respect to this fourth use that the Gantt Charts have become famous.

It should be observed that the principal purpose of such progress records is the maintenance of the flow of work through maintenance of the conditions (by discovery of lapses) on which the scheduling is based. They are not used directly for the appraisal of a worker's efficiency, for his efficiency should be judged by his normal or long-time performance. A different set of records is established for that purpose; a ledger card for each worker to which is posted, from his time-stamped work order slips, the quality of his performance on each operation. An operator's efficiency record is illustrated in Figure 85 and an operation efficiency record in Figure 86.[2] By means of such records the development of workers can be noted, the development of the efficiency of a given operation by all workers over a period of time be studied, and perhaps most important, the relation of actual accom-

When there is more than one reason for idleness, the reason entered on the chart is determined by asking questions in the following order:

R—Is the machine ready to run?
O—Is there an order for the machine?
M—Is there material ready to be worked on?
T—Are there tools?
P—Is there power to run the machine?
H—Is there an operator for the machine?

Circumstances sometimes change the relative importance of the reasons for idleness and it is then necessary to change the sequence of these questions.

[1] Figure 82 the V indicates that this chart was reproduced on March 3. An angle opening to the right indicates the date on which the material was to be issued from stores; the figures indicate the operations to be done on the order and are placed under the dates on which they were to be begun; an angle opening to the left indicates the date on which the parts were to be shipped. The heavy lines show what operations have been done; and the letters under the lines indicate the reasons for delay.

Reproduced by permission from "The Gantt Chart" by Wallace Clark, New York, The Ronald Press Company, 1923, pp. 25 and 86.

[2] *Bulletin of the Taylor Society*, Vol. VIII, No. 1, February, 1923, p. 20.

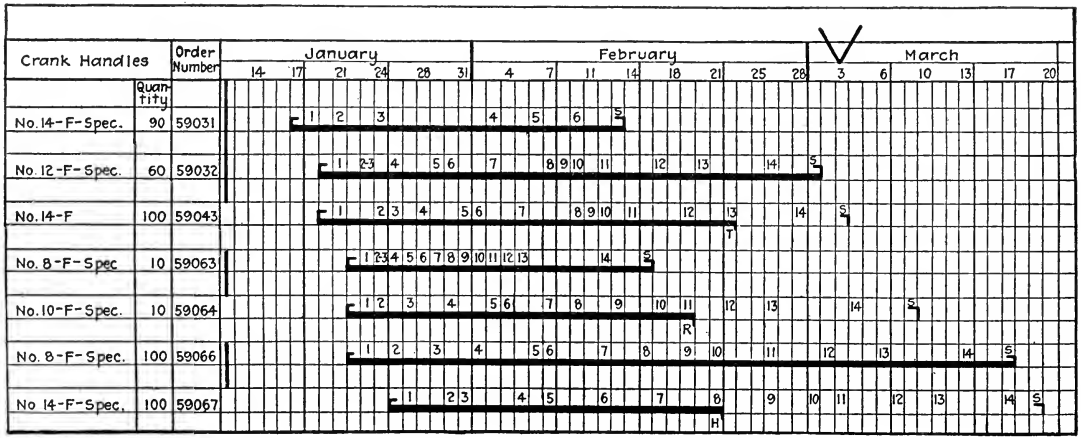

FIG. 82. GANTT PROGRESS CHART IN A PLANT WHICH MANUFACTURES TO ORDER
Reproduced by permission from "The Gantt Chart" by Wallace Clark, New York, The Ronald Press Company, 1923, p. 86

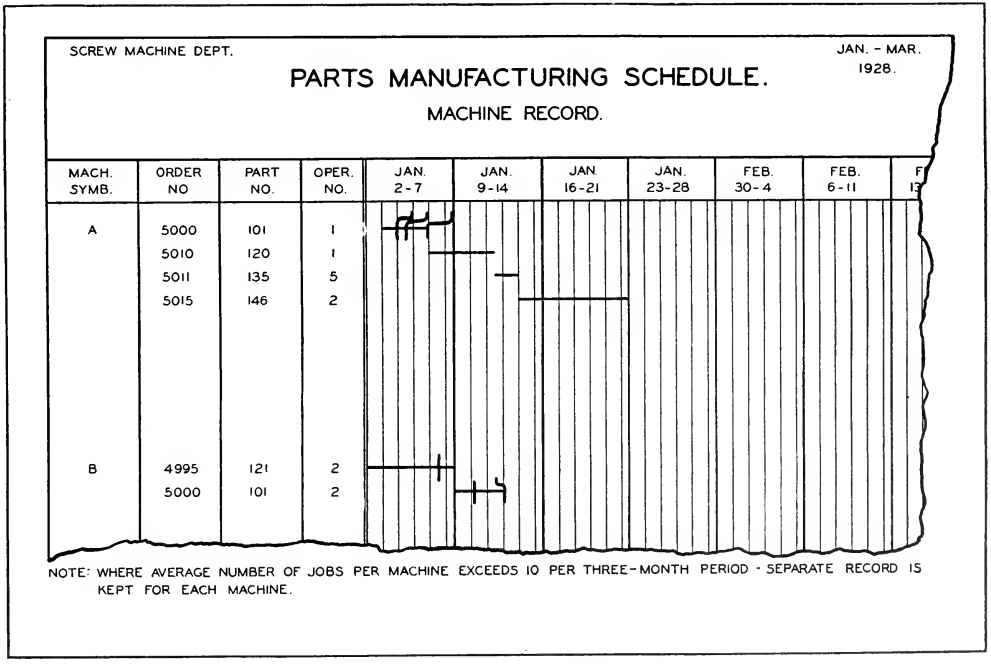

FIG. 83. A THOMPSON & LICHTNER CO. INC. MACHINE RECORD CHART

plishment to theoretical standards be brought to the attention of the methods division.

The detail in which progress and efficiency records are kept will vary among different types of operations. As in the case of physical inspection—or any kind of inspection—returns must be appraised in terms of the cost of the paper work. In the long run inspection must pay its way. But it should be observed, as was observed also in the preceding chapter, that during the period of development of new

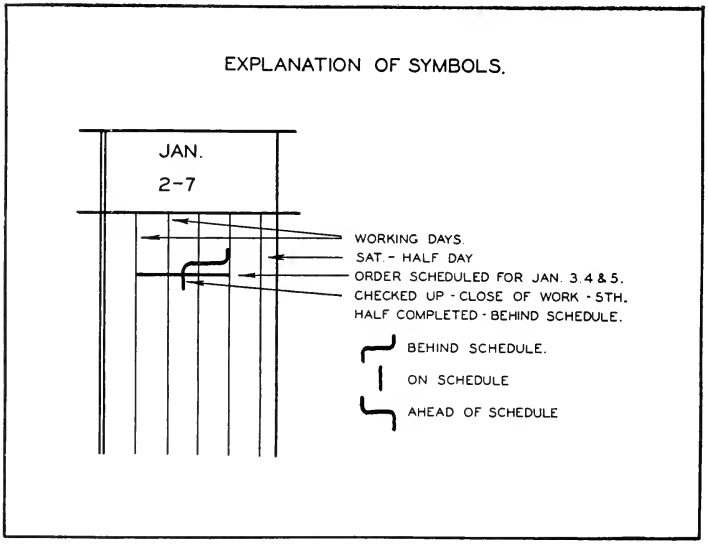

FIG. 84. EXPLANATION OF SYMBOLS ON FIG. 83

methods, inspection which does not pay its way is usually a good investment, for it helps to fix the habits required by the new methods.

Executive Performance. With precisely the same objectives this principle of continuous inspection has in recent years come to be applied to the field of executive performance. It could not come to be so applied until industry had learned how to construct standards for measurement of executive work, and it has been so applied only where and to the extent that such standards have been constructed.

Until recently it was the custom to measure executive performance by the annual financial reports—the balance sheet, the profit-and-loss statement, and certain ratios derived from these. If a sound balance

250-7097-5000-6-21-42-9

OPERATORS EFFICIENCY RECORD

CORONA TYPEWRITER COMPANY, INC. Transfered to dept 2 7/1/20

OPERATORS NAME W. Barnes

OPERATORS CLOCK NO. 102 Dept. 3 / 57 " 2 / " "

Date	Part or Job Number	Oper. No.	OPERATION NAME	Order Number	Method of Wage Payment P	Method of Wage Payment D	Reason for Day Work	Quantity Completed	100% Time per 100 Pieces	Total Hours Taken for Lot	REJECTIONS Paid for Q'ty	Paid for Reason	Not Paid for Q'ty	Not Paid for Reason	Scrap Produced	% Labor Eff.	Time Taken per 100 Pieces	100% Time Allowed For Lot
1920																		
6-1	X157	11	Mill card outlet hole	8803	✓			670	.1448	2.90	2	Broken drill			2	44		2.73
"	2192	H	Mill all holes	9971	✓			182	2.39	7.15						104		4.34
6-2	"	"	"	9257	✓			240	"	5.28	1	Broken drill			1	131		6.93
"	X210	23	Cop holder slot	9582	✓			58	.73	4.10						108		4.45
"	X90	19	Tube	7996	✓			2500	.119	2.48						119		2.97
6-3	2191	H	Mill all holes	9853	✓			773	1.51	11.20						131		14.06
6-4	"	"	" " "	"	✓			507	"	12.40	1	Broken drill			1	117		14.60
6-5	"	5	Burr all holes	9253	✓			1206	.583	3.91						97		3.83
"	—	—	Waiting for tool etc	—		✓	26	—	—	.23						—		—
6-5	MX174	5	Burr 3 holes	1378	✓			4110	.279	10.00						114		11.46
"	X17	H	Hole	8825	✓			1895	.367	4.11						117		5.77
6-12	2191	H	Mill all holes	9993	✓			2250	1.31	36.09						113		46.75
"	X151	14	Form timbers	8803	✓			1010	.15	1.34						112		1.51
"	—	—	Repairs & Improvement	—		✓	26	—	—	.25						—		—
6-17	2191	H	Mill all holes	9998	✓			1700	1.81	24.00	2	Broken drill			2	106		32.77
6-18	2195	5	Burr all holes	9257	✓			1408	.14	10.00						93		9.29
"	X151	13	Form & burr	9124		✓	1	800	.268	3.75						97		2.14
6-19	—	—	Labor replacement	—		✓	26	—	—	.23						—		—
6-21	1651	32	Form & burr	5140		✓	9	238	—	1.00						—		—
"	MX2214	5	Burr both ends	9464		✓	9	136	—	.76						—		—
"	MX92	51	Tie tap post	9133		✓	9	691	—	.89						—		—
"	X151	10	Wicket	8803		✓	7	1500	—	1.96						—	.13	—
"	MX93	51	Tie tap post	9710		✓	9	667	—	1.61						—		—
"	MX213	2	Burr	8066	✓			466	.28	1.14						114		1.30
6-24	2191	H	Mill all holes	9311	✓			2394	1.51	38.11						113		43.03
6-25	2192	H	Mill all holes	9999	✓			335	2.39	7.53						106		8.00
6-26	—	—	Waiting for tool etc	—		✓	26	—	—	.23						—		—
6-29	2192	H	Mill all holes	9856	✓			774	2.39	18.50						100		18.47
6-30	X151	11	Mill card outlet holes	8803	✓			1760	.1415	5.23	3	Broken drill			2	107		5.64
"	84	7	Countersink	8999	✓			2430	.20	8.22						112		8.13
June 1920			MONTHLY TOTALS AV. QUALITY EFF. AV. LABOR EFF. 112% PER CENT OF P. W. 95.6%						P W	209.61								240.25
									D W	9.87								
7-1	X210,	L	Called to Employment Office Burr edge & mill angle	9596		✓	41	400	531	3.40						57		2.12

NOTE—Record clerk will figure the average labor efficiency of each operator and the efficiency of quality at the end of each month. To find the average labor efficiency for the month divide the total of all items upon which a standard time is set, as shown in column headed "100% time allowed for lot," by the total of similar items in column headed "Total hours taken for lot." To find efficiency of quality, divide the total of all rejections and scrap, during the month, by the total of the column headed "Quantity completed" and deduct the quotient from 100.

FIG. 85. OPERATOR'S EFFICIENCY RECORD

sheet and profits were indicated, performance was appraised as satisfactory. If no profits were indicated, but yet a sound balance sheet condition in the light of general industrial conditions, performance might still be appraised as satisfactory—for it is assumed there must be ups and downs. There was no means of appraisal by comparison with what could have been, or what was attempted to be achieved, or by what would happen—with respect to inventory assets for instance—if industrial conditions should take a sudden turn for the worse. These more general methods of appraisal appeared to suffice when the United States enjoyed a fairly continuous sellers' market.

However, the severe depression which followed the war and the appearance of a prolonged buyers' market awakened industry to the realization that such methods of appraisal are not always sufficient. There was then a widespread shrinking of inventory values and general executives came to realize that both they and their departmental associates had been riding too comfortably and indifferently on calm seas, and that they had not exhibited that efficient seamanship which always keeps a ship in order. General executives, realizing that on them rested the major responsibility, jumped into action and became essentially merchandise managers, sales managers, financial managers, labor managers and production managers—in cooperation with departmental managers, of course—and among other things instituted systems of planning and of recording and appraising results of executive effort, which before had not seemed essential. The influence of banks, insurance companies and other large investors was also brought to bear on the development of standards for measurement of executive performance, for in 1921 and 1922 they came to realize that financial statements were not a sufficient basis for judgment whether enterprises which showed shrinkage in assets and operating losses should be supported or not; a general refusal to support those which by earlier superficial standards appeared to be in an unsatisfactory condition would have caused havoc in American industry. Therefore these financial institutions through engineers and other professional agencies and even their own created departments made detailed inquiries into such factors as physical equipment, executive capacity, use values of the commodities, labor conditions, and the system of management with respect to each enterprise, thereby appraising its basic soundness and probable success under more normal industrial conditions, as a basis for decision whether it should or should not be supported through the depression. Out of these emergency activities of general managers and credit institutions there rapidly developed standards for measuring performance which have taken their place as a part of the permanent mechanism of general administrative control.

289-7996-5000-6-21-6259

OPERATION EFFICIENCY RECORD

CORONA TYPEWRITER COMPANY, INC.

OPERATION NO. 5 NAME Mill Corner Grooves PART NO. 2Z1

Date 1920	Operator No.	Operator Name	Order Number	Method of Wage Payment P	Method of Wage Payment D	Reason for Day Work	Quantity Completed	100% Time per 100 Pieces	Total Hours Taken for Lot	Rejections Paid For Quantity	Rejections Paid For Reason	Rejections Not Paid For Quantity	Rejections Not Paid For Reason	Scrap Produced	Total Quantity Paid For	% Labor Eff.	Time Taken per 100 Pieces	100% Time Allowed For Lot
7-3	57	Baird	6844		✓	7	2063	—	15.68						2063	—	.76	—
7-17	53	Brown	"		✓	7	3075	—	224						3075	—	.72	—
7-26	57	Baird	"		✓	7	4080	—	23.26						4080	—	.57	—
7-30	1222	Dodge	"		✓	7	1010	—	6.16						1010	—	.61	—
July		MONTHLY TOTALS																
1920		AV. QUALITY EFF.		—				P.W.	—									
		AV. LABOR EFF.		O				D.W.	67.44									
		PER CENT OF P. W.		O														
8-6	1222	Dodge	7012		✓	7	1290	—	8.32						1290	—	.64	—
8-10	"	"	"		✓	7	750	—	3.14						750	—	.41	—
8-13	"	"	"	✓			1800	.37	7.01						1800	95	—	6.66
8-17	57	Baird	"	✓			2260	"	9.10						2260	92	—	8.36
8-23	"	"	"	✓			1698	"	5.87						1698	107	—	6.28
8-29	1222	Dodge	"	✓			2300	"	7.59						2300	112	—	8.51
Aug.		MONTHLY TOTALS																29.81
		AV. QUALITY EFF.		—				P.W.	29.57									

NOTE—Record clerk will figure the average labor efficiency of each operation and the efficiency of quality at the end of each month. To find the average labor efficiency for the month divide the total of the column headed "100% time allowed for lot," by the total of the column headed "Total hours taken for lot." To find the efficiency of quality, divide the total of all rejections and scrap, during the month, by the total of the column headed "Quantity completed" and deduct the quotient from 100.

FIG. 86. OPERATION EFFICIENCY RECORD

It is unnecessary to describe these standards of measurement in detail; they have been described in earlier chapters.[1] Most important are the budget, the master schedule of operations for the enterprise as a whole; the detailed operating schedules—derived from the master schedule—of the sales, production and other departments; and certain ratios which constitute standards of proportion between factors of management. The significance of these devices is that they establish for the enterprise as a whole, of which entire departments become for the purpose the unit work places, a counterpart of the planning department which scientific management many years ago established for the production department. The schedule of sales, the schedule of production, and the schedule of personnel requirements, for a definite period of six months or a year or longer, are for the sales, production and personnel departments, respectively, what the operation schedule is to a shop foreman and the work order slip is to the individual operative—a plan, a task, a standard by which to measure performance. Today every function is provided with a definite target at which to aim.

There is this fundamental difference, however; executives are more concerned with imponderables and variables than are production operatives. Planning, preparation and continuing inspection can succeed in holding fairly constant the physical characteristics of plant, machine, tools, materials and method. Here is a large area of constants with which the production staff may work. Its area of imponderables and variables—although sufficiently perplexing—is much reduced; the dominant factors in this area are variations in the production volume which come to it from sales and variations in human nature. But the executive must work with a larger proportion of unknowns—industrial conditions and tendencies, the state of the market, changes in customer requirements, the influence of legislation and public opinion. Therefore the standards to which executives must work cannot be as precise as are those to which the production group works. There is not a comparable factual basis for plans; judgment and even guessing are involved. Therefore appraisal in terms of the standards cannot be as precise.

In this connection the significance, as a mechanism for appraising performance, of John Williams' flexible budget[2] should be noted. Generally budgets, even the best of budgets, set one definite task for the forecasted period on the assumption of a specified volume of sales. From this assumed volume of sales are computed all detailed budgets and schedules, including for instance the cost of performing each departmental unit of the total task. But sales may vary considerably

[1] Cf. Chapters IV, XI and XIX. [2] Cf. Chapter XIX.

from the estimated volume, and because of the varying ratio, as volume varies, of fixed to variable elements in cost, the cost of performing a departmental task will not vary in direct proportion to the changes in volume of sales. The elements of the original budget cease to be just standards by which to measure the efficiency, as indicated by cost, of departmental performance. Therefore Mr. Williams constructs several budgets: for minimum, maximum and intermediate volumes of estimated sales; and for any given month that particular budget is used, as a standard by which to judge individual executive performance, which corresponds most closely to the current actual volume of sales.

With respect to inspection as a procedure for discovering deterioration in executive standards, or variation from estimated conditions, attention should be directed to the exception principle so strongly emphasized by Taylor. There should be, of course, constant inspection of every unit of performance by routine comparison of results and costs with the corresponding items of the predetermined plan; but only those items should be brought to executive attention which disclose serious variation from the predetermined standard. It is on these variations from the expected that a chief executive should concentrate his attention, either for the purpose of bringing his larger experience to bear on correction of unfavorable conditions, or for the purpose of modifying aims—perhaps even policy—if the unexpected unfavorable conditions cannot be changed. It is by inspection of this sort that the entire executive staff is enabled to concentrate upon the unfavorable influence of the unexpected, immediately and effectively, before that influence has had serious consequences for the enterprise.

In the field of executive responsibility, therefore, as well as in the shop, inspection values its function of discovering necessity and opportunity for common helpfulness as highly as it values its function of appraisal of executive efficiency.

REFERENCES

Clark, Wallace, *The Gantt Chart,* New York, The Ronald Press Company, 1922.

Porter, David B., "Charts," *Management's Handbook,* edited by L. P. Alford, New York, The Ronald Press Company, 1924, pp. 171-191.

Cf. references to Chapters XV, XIX, XXII, and XXIII.

CHAPTER XXV

THE MAINTENANCE OF LABOR STANDARDS[1]

SINCE any operating standards are neither maintained nor improved without supervision, the value of such check-up will be as great in the field of personnel policies as elsewhere. The fact that there are here a number of imponderables, of facts and forces of almost wholly subjective character, does not lessen this need; rather it increases it. For the very subtlety of the elements of the problem of maintaining in force labor policies which will be progressively effective requires special care in analysis, in statement, in the proposing of new policies and in their introduction. In fact, it is safe to say that the more intangible the standards the more important is their evaluation. Also, as in this case, the more dependent the effectiveness of the total organization upon a given class of standards, the more necessary it is to protect them. The case for maintaining standards in all matters affected with a personnel interest thus needs no argument.

Unlike standards of taps or drills, or those embodied in the specifications of working methods or in time-study results, standards in the field of personnel management are conditioned continually by psychological factors which make this field peculiarly dynamic and, to use a helpful new word of the social sciences, emergent. In a limited sense certain standards can be fixed, accurately recorded, and checked. This is essential to good management. But in the larger sense certain other standards which affect the working attitudes and relations of employees to an organization, are satisfactory and valid only temporarily and in relation to competitive conditions, community reactions, consumer sentiment and working-class outlook and progress. It is this fact which makes the maintenance of labor standards a problem not merely technical in a limited sense, but one of industrial statesmanship, entailing for proper maintenance or revision an outlook and training of a rather unusual sort.

Inspection of Current Standards. Considering first the question of maintaining existing standards in the operating divisions of a personnel department, one most vividly suggests the nature of the problem by referring the reader to Chapter VIII. It was there pointed out that research to determine standards in this field requires examination of the fields of selection, training, health and safety, service work

[1] By Ordway Tead, Editor of Economic and Business Books, Harper & Brothers, New York; Lecturer in Personnel Administration, Columbia University, New York.

and joint negotiation and adjustment. Naturally, the inspection and check-up of personnel standards will therefore be required in these same fields of investigation.

In the first instance, such check-up should come from the operating executive in charge of a unit. The heads of such units as employment, training, health and safety will be the ones directly responsible for maintenance of the standards set for their divisions. The specific methods which will assure this review of results may vary greatly with local conditions. A company hiring two hundred people a week has obviously a different problem of interview inspection from one hiring five; similarly in the other functional divisions. But the difference is quantitative only. The desired end is the same; namely, to be sure that as soon as any notable change from normal is taking place, the fact is noted and the reasons ascertained. A doctor who finds, for example, a rapid increase in patients suffering from aniline oil fumes in one department will realize that there is something seriously wrong with machinery, ventilation, equipment or processing methods, which necessitates executive action.

An employment interviewer who discovers that one foreman out of a dozen is responsible for half the separations taking place from the entire company, will want to know what is the matter with that foreman's methods.

How often each executive must check his own operating results depends thus upon the size of his responsibilities. But if his standards of normalcy are explicit, and if his system of record keeping is adequate, this should not prove difficult. Indeed, the existence of the standards almost automatically suggests the type of records that a given operating unit will require.

The correction of shortcomings between standards and actual results becomes also a real part of the problem of maintenance. Here again it is difficult to lay down a rule of universal application. The doctor in the case above suggested may be confronted with a condition productive of occupational disease that only the expenditure of some thousands of dollars can correct. A training director may be handicapped because he has no classroom or no duplicate machines at which to train. To talk in most cases of maintaining standards means at once that action is required among a group of higher executives who can be instrumental in authorizing appropriations.

The important thing is to be sure that when such serious departures from standard are noted, they be brought authoritatively to the attention of those executives whose action can bring results. Some companies find that they can secure the best results by letting the personnel executive authorize all unusual and unbudgeted outlays up to a certain

amount, and requiring amounts above that to be authorized by the company's executive committee. Some standard practice for giving adequate responsibility to each executive for maintaining the standards of which he is in charge, is an important corollary here.

Inspection of Standards in Relation to Policies. The direct check-up of day-to-day activities is, then, less of a problem than is the assuring that all these individual standards in selection, training, health, and so on, are continuously *working together* to give force to those standards of company labor policy as a whole which the head executives wish to see in force. It is not infrequent that some one feature like a company's medical work or its service work maintains high standards while nevertheless the total working morale of the rank and file is far from satisfactory. Here the problem of maintaining a standard for the company labor policy in its total effectiveness in action, is far more difficult. In all probability in such cases what is needed is a searching review of the personnel policies and methods of the organization in their entirety and from a disinterested and perhaps even outside point of view. It is not suggested, of course, that a standard of good company morale can be stated in a formula or equation in which all the factors when correctly evaluated tell when morale is present. But it certainly is true that head executives and owners do frequently have in mind a kind of working spirit for their organization which they can (or think they can) more or less sense when it is present, and the absence of which they can detect and deplore.

Such a by no means unusual condition of unbalanced development in different phases of a company's personnel policy has brought into relief the need for a broader instrument and technique of inquiry than the more specific measures and records suggested above. If it may be assumed that many organizations—at least those which are trying to administer themselves under precise, scientific, and progressive methods—do have certain objectives of employee good-will, cordiality, and total organization cooperativeness which they wish to see in action, then the maintenance of all the conditions which contribute to such a happy attitude is obviously vital. And more than that, some analytical technique is required which will point to many perhaps unrecognized forces which help or prevent a condition of affairs which makes for the fulfilment of such a standard.

A method for such a scrutinizing of organization personnel standards in their totality is at hand in what may be called an "industrial relations survey" or "labor audit," the latter of which terms will be here used to connote the methodology which will now be outlined.

Labor Audits. *Definition.* A labor audit is a systematic and reasonably exhaustive analysis and statement of the facts and forces

in an organization which affect the relations between the employees and the management; which in other words condition the morale of the entire organization.

From the point of view of the continued operation of sound management policies such an examination should be made at periodic intervals, exactly as is a financial audit. Probably in this field once a year is often enough to assure a proper appraisal.

Whether this analysis should be undertaken by executives in the organization, or by outside consultants—just as financial audits are made by certified public accountants—is a question to which there is no one answer. If the chief personnel executive is highly competent, there is much to be said for such an annual survey being made under his direction with perhaps an outside consultant being brought in every third year. If a company's labor standards seem to be working badly, that is often *prima facie* evidence that an outsider's view would be highly profitable. Indeed the labor audit under certain conditions might be made by a private foundation (such as the Russell Sage Foundation), by a labor union, or by a governmental body such as a state department of labor or an *ad hoc* commission. In this volume the problems and uses of the audit as made either by the personnel manager himself or by a professional consultant will be those specially stressed. And it will further be assumed that the examination to be made is to be carried on periodically at intervals of one year, since that supplies a time unit of sufficient length to observe important changes in methods and results.

The aspects of the subject which experience shows to require special consideration are: the labor auditor himself; the method of the audit, including the character of the check list and the means of procuring the data; the method of presentation; and the best ways to utilize the finished audit.

1. *The Labor Auditor.* The examination of labor standards will be no better than the ability and training of the auditor permit it to be. His outlook, background and insight are in this field peculiarly limiting factors in the effectiveness of his work, since he is fundamentally in search of many facts which cannot be weighed, measured or recorded with statistical precision. Explicitly should be mentioned here his training, his attitude and his objectives.

His training should include a thorough working knowledge of what other companies are doing and have done (successfully and otherwise) in the entire range of personnel activities. The standards he wants either to maintain or to advance are frequently not new and untried, but have somebody of informing, comparable experience behind them.

His ability as a salesman for his ideas will be greatly enhanced by his ability to quote line and page from the history of other organizations.

Also his training must have enabled him to understand what kinds of facts, factors and influences do have personnel implications—do tend to affect in one way or another the working attitude of the entire membership of the organization. This sense for the relevancy of the subject matter to be covered is absolutely indispensable to his success. Increasingly, of course, established check lists can supply him with suggestions as to the varied items to be examined, if thoroughness is to be achieved. But there should be additionally the conviction in his mind of their relevancy and of the reasons why they are relevant.

His conception of what facts are relevant will be colored by the extent of his awareness of the trends in economic and industrial organization throughout the country and the world. The point should not require elaboration today, that the labor auditor should have a sense for the increasingly democratic sentiment actuating all peoples in all lands and being applied more and more to the issues of industrial life. Some understanding of and sympathy with this democratic trend will help the auditor to know what to look for and to comprehend what he finds.

A final element in his training should be a vivid realization of the educational methods which are today understood to be most effective in getting ideas over to other people. The auditor in this field is only half an inspector and recorder; he is in his more important half an interpreter and teacher. For the maintenance of personnel standards requires not merely observation and analysis; it requires ability to make executives see when certain intangible standards are not being lived up to and when the influence of others is not in the direction expected or desired. Hence the necessity for a command of what is essentially a teaching technique. This involves, as was said in a previous chapter,[1] ability to make others share in the essence of one's experiences as the basis for their grasping and feeling the significance of one's conclusions. It is not possible here to elaborate this fundamental psychological point beyond saying that of the two major methods of learning—from one's own current experience and from one's mental rehearsal of prior experience, which is reasoning—the former is for most people the most used and most telling method. The auditor must make those to whom he is reporting aware not merely in a verbal way, but in what may be called an experiential way, of the facts he finds. And he will know that the mere reading of reports by executives usually conveys to them but a fraction of the truth he has to impart. He will find that many of his executive associates will be predominantly

[1] Cf. Chapter VIII.

motor-minded, which means that they are influenced and mentally implicated only by their own actual motor and mental experiences—by being placed in problem situations which they identify as such and then try to solve as an integral necessity for the restoring of their own peace of mind.

The attitude of the auditor is also important. It must be scientific, of course, and it must in part at least be professional—by which is meant that it must be an attitude that adheres to standards and aims which are not wholly governed by immediate consideration of business profit. Just as the certified public accountant gains part of his value by his adherence to professional standards of procedure, interpretation and disinterested statement of fact, so here the auditor, be he personnel manager or outside consultant, gains greatly in value even from the strictly business point of view if his attitude is one of recording facts and failures regardless of who is involved thereby. This does not mean a chronic, sweeping use of open criticism; rather it means a fundamental honesty in stating at the right time and place and in the right manner the results he has obtained. The essence of his integrity is not measured by his bluntness but by his diplomacy in making the right individuals aware at the right time of the failures for which they are responsible. And he gains his greatest value as an auditor of an organization's personnel balance sheet only as he points out all the losses and discrepancies he sees. To soft pedal here is to defeat the ends of his whole effort, exactly as it is true that for him to be too reactionary or conservative in his judgments would likewise defeat his greatest utility. For if he is not ahead of his executive associates in his knowledge and appreciation of the morale factors in business—those factors which change and progress with the mood of the times and the temper of working people's outlook—he will not long remain of any real value to his organization.

This leads to a mention of his objectives. His immediate objective is completeness of fact knowledge, clarity of fact statement, and accuracy in fact interpretation. But because of the peculiar nature of his problem and of the medium with which he so largely works—namely, human nature—he should have a further objective of being able to suggest to executives and help them to change to *new personnel standards* as the limitations and handicaps of present standards become clear to him. One may not ordinarily, for example, think of the existence and use of an employee representation plan as one item of personnel standard practice, yet it is now in fact exactly that in many organizations. And the conditions of working attitude and spirit in a given concern might well prompt an auditor to advise the introduction of this procedure as a necessary new standard. An

objective of merely dispassionate fact statement alone will be inadequate just because *the maintenance of standards in this field is psychologically impossible to achieve if what is really demanded by the situation is new and more progressive standards*—standards which reflect changes in employee sentiment and recognize shifts in employee interest, enthusiasm and possible loyalty. *Standards, in short, in the personnel field, do not and cannot continue long in force in dissociation from each individual employee's readiness to recognize them as reasonable and authoritative for him no less than for the organization as a whole.* That is why the labor auditor must rather uniquely have an objective which includes proposing and helping to change standards no less than maintaining them.

It is these considerations which require of him both the training, the temperament, the attitude and the objective of the meliorist—of that high order of opportunist who is alive to the problem situations in every organization's growth in morale, and who is able to capitalize on those problem situations to effect changes and developments in personnel standards and policies.

2. *The Check List.* It is doubtful whether any one best master check list of items to be reviewed and questions to be asked will be evolved in the near future. A number of such check lists and questionnaires exist today; others will undoubtedly be composed. But some scheme, logically conceived and approximately thorough in its coverage of relevant items, is essential as a guide and as a basis for the selection of the items to be studied as influential in any one given situation. The brief outline of major topical headings presented below aims only to be suggestive of the skeleton which must be elaborately filled in with items and questions if all the points of inquiry are to be covered. It is presented not as a model so much as a hint of the kind of itemization which should be available for the guidance of the auditor:[1]

a. Employment

Sources of labor supply
Selection
Placement at work
Following up new workers
Transfer
Promotion
Discharge
Employment records
Labor turnover records

b. Terms of employment

Wages
Amounts and methods
Hours
Indirect compensation

[1] For further details see Tead and Metcalf's *Personnel Administration*, New York, McGraw-Hill Book Company, 1926, Chapters XX and XXI; and Tead's "The Labor Audit," *Bulletin 43*, Washington, Federal Board for Vocational Education, 1920.

Group life insurance
Health insurance
Unemployment insurance
Stock purchase plans
Profit-sharing plans
Pensions
Production standards

c. Health and safety

Medical department organization
Safety department organization
Fire hazards
Accident hazards
Ventilation and heating
Lighting
Plant housekeeping
Drinking water
Sanitary equipment
Seating, and rest rooms
Dressing rooms
Noise and vibration
Factory exterior

d. Training

Job instruction
Foreman instruction
Executives' instruction
Americanization
Training for promotion
Inspection
Suggestion systems
Company house organ

e. Service work

Restaurant and lunch rooms
Saving facilities
Housing
Recreational activities
Cooperative purchasing

f. Research

Job analysis
Job specifications
Labor audit
Medical research

g. Negotiation and adjustment

Conference methods
Employee representation plans
Collective agreements with trade unions

h. Managerial policies, methods, opinions (as bearing on personnel policies)

Production organization
Sales organization
Financial organization
Personnel organization
Coordination of staff and line departments
Outstanding economic beliefs of owners and executives

i. Outside relations

Employers' associations
Trade unions
Labor legislation
Labor law enforcement
Court decisions
Transportation
Public education
Public health

3. *Sources of Information.* Of suggestive value also should be a list of the usually available or compilable information within the organization, that will help to disclose the true condition of sentiment and attitude among its personnel. The following sources are suggested as the first to be sought:

a. The number, causes and cost of accidents.

b. The amount, causes and cost of sickness.

c. The amount, causes and cost of occupational disease.

d. Figures showing the relation between wages and output; between hours and output; between labor turnover and output. This correlation of data is highly significant. It may not always be possible to secure it; but there is unquestionably one of the most fertile fields for statistical refinement in this problem of correlating the figures on the production and the human side of business.

e. Length of employment of workers and leavers. It is important to know what percentage of workers has been at work for a given length of time and the length of stay of the leavers.

f. Wage groupings by amounts both in terms of weekly and yearly incomes, sex, age, length of service, degree of skill. This arrangement of wage statistics will almost invariably throw light upon the efficiency of the company's payment methods and upon any serious discrepancies and shortcomings in amounts of pay. Companies do not usually compile their figures in this way, but if when the labor auditor commences his work he can call for a certain amount of clerical assistance, a good deal of this data may be collected during his visit—usually enough to make it possible to have a factual basis for his discussion.

g. Records of labor turnover, lay-offs, and discharges. To be significant these records should be itemized in various ways, but especially by departments, sex, length of service, amounts of pay, and so on.

h. Records of quality of work, amount of waste, number of seconds or defective goods.

i. Training costs.

j. Costs of service work.

The adequate compilation of continuous current records is one of the immediate ends for which the consultant will often have to strive with some pains. Many companies do not keep records of the above character with any permanency, and have no idea what the situation is regarding these personnel facts. It is not until the significance of more adequate control over these important items is understood that a proper interest in this type of statistical work arises. However, the executive who has seen the beneficial results of a more careful control of production costs, can usually be convinced that a certain minimum of personnel record figures will be immensely valuable.

In addition to the existing statistical data there will be a certain amount of documentary material which the auditor will examine with profit before he goes into the plant. He will familiarize himself, for example, with profit-sharing arrangements, constitutions of mutual benefit societies and employees' representation schemes, minutes of

meetings of executives' groups, foremen's clubs, and employees' organizations, the files of the company paper or house organ, and similar sources of information about all the different personnel activities.

With the background of facts which all the above sources can supply, the auditor is now ready to interview the members of the organization. The first interview will naturally be with the highest executive, with whom the auditor takes up especially problems of the determination of personnel policy and the nature of the policy under which the company at present operates. It will be important to get from him as clear a picture as possible of the division of responsibility and of authority in the organization. In this connection it will be helpful to secure or have made an organization chart of the executive structure as a whole. It cannot be too greatly stressed that at the bottom of many personnel problems is the fact that responsibility is vaguely assigned, and that authority is not clearly designated on important matters of administration. Indeed, the auditor's efforts in the direction of clarifying functions are not simply a necessary part of his grasp of his problem; they are also invaluable to the company.

The wise auditor will usually conduct his personal interviews with the executives from the top down in the order of their responsibility and authority. In these interviews he will in many cases repeat the same questions—questions having to do with the responsibility and authority of the individual, those aiming to make clear his conception of the labor policy under which the company operates, those aiming to secure his evaluation of the success of that policy. The auditor will save himself considerable misunderstanding and will avoid confusion if he says specifically to executives who are outside the field of immediate personnel administration, that he is not talking to them as an expert in their field, but *is speaking to them only in his capacity as a labor expert anxious to understand how their problems affect the labor problem of the management.*

In the course of such interviews he will necessarily have to work through a good deal of chaff to get the wheat, since many specialists are eager and proud to describe the technical work in which they excel. And it is only with difficulty, and often incidentally, that they will let fall any information which throws light on the labor aspects of their technical problems. For this reason the method of direct questioning must occasionally give way to patient waiting for an executive to tell his own story in his own way.

With the general knowledge of plant organization, policy and practice, which the interviews with executives should afford, the auditor will then confer individually with each foreman or line department head. In this way he will get a valuable corroboration or denial of

the statements which the higher executives have made. He is frequently astonished to see the wide discrepancies between the stories which the higher and lower executives tell, as to the definition of responsibility and the character of the policy under which the company is operating. The labor auditor has a major task in helping to clarify this situation and remove misunderstandings.

In the interviews with subordinate line executives he will concern himself also with the detail of the individual executive's methods of running his department. It is one of the substantial by-products of the auditor's work that he comes to have a fairly good estimate of the competence of the various executives for their jobs, and he will know which of them are most successful in carrying on their work as it affects employee attitudes.

The extent to which the auditor has direct interviews with the rank and file of employees is a hard point on which to lay down a general statement. In one way or another he must feel the pulse of employee attitude and opinion. Where there is some articulate organization among the employees this task may be somewhat easier, although whether or not such organization does truly represent the bulk of employee sentiment is one of the questions to which he is, of course, seeking an answer.

There is room for a good deal of development of technique on this point. Casual questioning of employees at their work places is not usually likely to yield accurate results. The method of sampling employee opinion by the use of a more or less set group of leading questions can undoubtedly be further developed.[1] The present dangers are that employees will make the answers they think are wanted or are expected of them; that they will be influenced by the form of the question to give an obvious reply; that they will be afraid to talk; that the most articulate workers will not necessarily be the most representative. This all suggests that in some way or other the work of the labor auditor should be explained in advance to the entire organization; and here again a representative employee organization can often be a useful interpretive medium.

The auditor will also get much light upon the practical working of the company's human relations activities if he attends as many as possible of the executives' or workers' conferences or committee meetings which take place during his stay in the organization. Not infrequently an operating committee of the executive staff has daily meetings. Attendance at these meetings usually brings out suggestive information, even though many of the problems treated have no direct bearing upon the personnel question. The same will be true of fore-

[1] Much has been done along this line by J. David Houser; cf. Chapter VIII.

men's meetings, councils, and conferences held both for business and for social purposes. If there are meetings of employees' organizations of any sort, which the auditor may attend without being too conspicuously out of place, this also will be valuable.

Finally, there is sometimes interesting evidence in the local community as to the reputation of the organization from the point of view of labor policy, which it is important and revealing to secure by interviewing local people. The good opinion of the locality is necessary from the angle of labor supply and usually where that good opinion is absent there are reasons for it of which the company should be explicitly aware.

After facts are gathered it is important to check them. This should first be done by the one who compiles them and after that there should be a joint checking up with those from whom they are obtained. It is usually best to submit a written statement of facts for joint consideration between auditor and executives before proceeding to make criticisms or recommendations.

4. *Presentation of the Audit.* From all that has gone before it should be clear that an audit is comprised of three distinct parts: it states facts; it evaluates them from the auditor's point of view; it offers recommendations growing out of the conditions discovered and evaluated. Vital to the success of all audit work is a clear separation at all times of these three parts of the job. To confuse facts and opinions and to mix opinions with recommendations is to weaken the entire effort.

Assuming then that any presentation keeps these three elements clear and distinct, the method of imparting this material most effectively must be considered by the auditor. A long typewritten report, which is the usual result of his labors, *is in reality only the beginning, not the end, of his work of presentation.* Of course the report is divided into the three sections of facts, evaluations, and recommendations. Each section can be prefaced by a brief summary. Every device to assure easy reading should be employed, but the reading of the document will not, for those numerous executives who have poor reading habits, be the best way for them to get the gist of the report. Individual conferences, group conferences, out-loud reading to executives, oral abstracts, detailed consideration of the report section by section—these are all useful. Nevertheless, the several high executives of the organization should be urged to read the report as a whole and so far as possible at one sitting, to get a picture of the situation as a whole as it has come through the auditor's mind.

The danger always is that the educational uses of the report will be minimized by the auditor once a written document is in hand. It will

be the line of least resistance for him simply to draw out information as quickly as possible, draw conclusions in his own mind, write as effective a report as possible, setting forth the facts and his recommendations, and consider that his work is then ended. The trouble with this method is that it is likely to lead to the futile consequence that his report is simply read and filed away without action being taken, or without enough action being taken to bring about a real maintenance of or change in policy. Emphatically the process of making an audit is *not* simply the writing of a report. *It is a process of constant education through personal contact, conference, discussion, question and answer.* Half the educational value is on this personal side, and to ignore it is to miss the real opportunity for most rapid improvement.

In short, the auditor must sell his ideas as he goes along, both by the way in which he asks his questions and by the way in which their assent to the facts brings the executives naturally to an acceptance of the auditor's conclusions.

5. *Using the Audit.* If it may be assumed that a review of accomplishment in the field of personnel policies and activities is being made yearly, the first use of the audit is to offer a basis of comparison with past performance. Are standards being maintained better or worse than a year ago? Are the standards seemingly as valid as they were, or are new and more advanced standards called for? The head executives and the personnel manager himself are the ones to profit in the first instance by this use. They are supplied here with facts which make possible as never before a real searching of the heart and mind as to the success of their objectives and their activities.

Since the audit is in effect a picture of company labor policy and history for the preceding year, it also supplies a valuable educational source book for junior executives in training. They will find here both a record and an interpretation which will make them comprehensibly informed upon company procedure much more quickly than by the more random method of gradually picking up the facts.

The same is true of the process of inducting new executives into the staff. They can save themselves much time and costly error if they will read the audits of the company running back over several years. For the audit will be found to supply as a by-product that history of success and failure in the personnel field which should prevent the repetition of mistakes—a history which the other staff departments in most organizations do not compile and therefore do not have available as an object lesson of past trials and errors.

Individual sections of the audit will also repay intensive study by subexecutives' conferences and classes. And some of the sections should undoubtedly receive thoughtful attention from the employees'

organization where there is one. It would seem obvious, in short, that a considered analysis by one or two trained minds of the whole personnel standard practice of a company would merit executive study and would supply stimulating evidence as to the next steps in improvement which might be taken.

The problem of the maintenance of personnel standards cannot, of course, be reduced to any formula. Whether one is thinking of inspection of procedures, evaluation of morale standards in action, or the employee reaction to existing or proposed standards, the basic elements in the situation are always psychological and elusive. This requires that the auditor have a special intellectual equipment and that an educational motive dominate his activity.

Finally, it must be fully realized by all concerned that standards cannot be maintained or altered without taking into account the opinion and reaction of the employees whose task it is to maintain them in use. That realization in itself should supply one sufficient reason why it will be profitable to every executive organization to install and continue some formalized method for auditing its personnel policies and procedures at regular intervals. For the knowledge thus obtained should aid greatly in keeping standards and the accomplishments and human desires of the entire personnel reconciled in a felicitous and productive way.

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Cf. also references following Chapter VIII.

CHAPTER XXVI

INSPECTIONS OF RESULTS IN TERMS OF COST[1]

Cost accounting serves management by evaluating the losses in expected profits when management standards are not attained, or the gain in profits when organization ability is effective in raising management standards. It points out the sources of these gains or losses promptly. This is vital, in order that corrective measures may be taken promptly in the case of a loss, or that individuals responsible for gains can be adequately rewarded and encouraged.

Purpose. Cost accounting is considered to have two main purposes: to aid in effective control of operations, and to serve as a factor in determining prices for the trade. The use of cost systems in setting of prices is generally overemphasized in contrast to its use as an instrument of control. Prices are really set in a whirl of competition, and costs serve primarily as a guide in the acceptance or rejection of available business at a price determined by the market. Only the very efficient companies in any industry can *demand* a fair profit. Of recent years relatively overequipped, competitive industries have been experiencing a period of falling prices, and increased efficiency is mandatory in any company during such a period.

This chapter will therefore be concerned mainly with the first purpose of cost accounting, the effective control of operations. This requires that sales, production and expense standards compiled in the operating budget be not only maintained by constant vigilance on the part of all executives, but that ingenuity and ability must be exercised to raise these standards to keep pace with the multifarious changes in market conditions.

Modern cost methods are designed to point immediately to the cost of the variations from the standards set, in day-to-day operation of the business. These variations are due to:

1. The effectiveness of wage-payment schemes in increasing production over the standard rate; and the corresponding effect on output of increasing or decreasing salaries, wages, number of employees, purchase of new equipment, etc.

2. The use of skilled labor for work which can be performed by unskilled or semi-skilled labor; likewise using a machine which is not correctly speeded or adjusted for the operation.

[1] By Norris M. Perris, member of firm, Stevenson, Harrison and Jordan, New York.

3. Losses resulting from frequent set-ups as the result of poor planning of production, such as improper scheduling, or from small uneconomical manufacturing lots due to poor stockkeeping.

4. Delays caused by breakdowns of machinery; also excessive repair expense causing a variation in cost.

5. Wastes in materials beyond the normal amount allowed in computing the quantity required for the article.

6. Losses caused by using different qualities of material with the consequent scrap loss.

All of these are primarily concerned with plant and office. The following are a few sales facts to be gleaned from the cost analysis:

1. Losses resulting from failure to realize sales quotas, upon which the budget is set. Losses are analyzed as to increased sales cost as well as loss in increased manufacturing cost due to spreading fixed charges over a decreased production volume.

2. Making price changes to acquire volume, and a decrease in profit margin that is taken to absorb idle time cost in times of depression. In theory this should increase profits by the amount of overhead absorbed by this decreased idle time. Does it actually increase profits in practice?

3. The value of additional sales expense spent with the thought of increasing volume; analysis of the increase in advertising appropriation and additional salesmen versus increase in expected sales, etc.

The reasons for the variations in costs from budget standard give the executive and his men a common ground upon which to discuss progress being made in the business. It paves the way for executive action by the man at the top steering the ship and the man below performing the routine operation. The executive and his men understand what is to be done, and through a proper form of compensation on a merit basis, they are rewarded for the effective manner in which they contribute to the accomplishment of the business.

Principles of Good Cost Control. To fix adequately the responsibility for variations in cost from standard, the standards of performance and the cost methods used must be technically correct. The cost system should reveal a true cost of the effort necessary to perform the various processes used in making the product, various clerical routines and various distribution methods employed. If it does not do this the responsibility for the variation in cost would be assigned to the wrong individuals, which would destroy the perfect harmony and cooperation necessary to control and improve existing standards.

It must be simple to operate and to understand. When a cost control is cumbersome in operation, highly-skilled men must give their

time to operating the control details when that time should be spent in reducing operation costs by study of these variations.

Information on variations from standards must be gathered promptly so that effective measures are taken at once to prevent any loss. It must point to the exceptional matters requiring instant attention. The profit and loss and other statements must force an executive to face the facts. The chief executive must know how much profit actually has been made, how much profit should have been made at prevailing prices, and why they were not made.

The cost system should be an integral part of the daily routine of putting orders through the factory and sales departments, using production and sales forms and reports as its basis for gathering the facts for the cost records.

Setting Standard Costs. The detail of setting standard costs is as follows:

1. Write the budget of expense incurred for each activity or department of the business into centers or cost accounts kept in a separate cost ledger. These items are arranged into controllable and uncontrollable items.

2. Based on a budget of expenses and standard units of work done in each center, compute a standard cost per manufacturing unit, such as standard labor and overhead cost per hour to operate a machine. This is done by dividing the year's budget of expense for the unit by the number of hours worked in a year. If a machine or bench operates 2,500 hours a year and costs $2,500 a year to run, the standard labor and overhead cost per hour is $1.

3. The standard time allowed for each operation as determined by time study, is multiplied by a machine-hour rate obtained in (2) above to give the standard cost of the operation. If it takes two hours to make one hundred pounds of a certain formula, the standard cost per one hundred pounds is 2 x $1 or $2 for the operation. The standard labor and overhead cost of making the finished product is the sum of the standard labor and overhead cost of all the operations required to produce it, based on standard operating conditions.

4. A standard material cost is set up by multiplying the standard quantity of material to be used by a standard price per unit of that material. In setting the standard price per unit for the material, the last inventory price is taken.

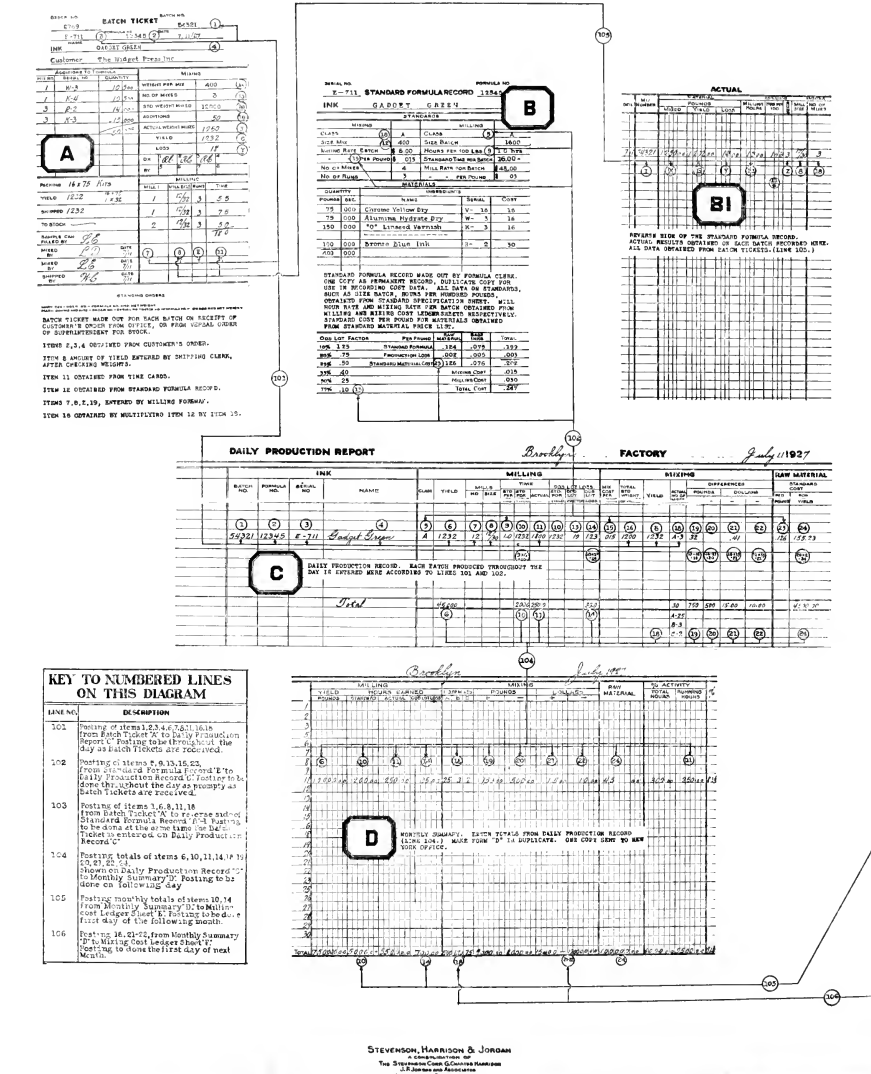
5. A standard administration and selling allowance per unit, based on the budget of these activities, is obtained in these centers. This allowance is added to the standard cost of labor, overhead and material, to give a total standard cost of that formula.

Having set up the cost under standard conditions of performance and expense, the entire procedure becomes one of recording perform-

9	LABORATORY & MATCHING					
10	GENERAL FACTORY	60,000.00	5,000.00	5,000.00	5,000.00	35,000.00
11						
12						

DETAIL STATEMENT OF OPERATING PROFIT AND LOSS

FACTORY COST ROUTINE



KEY TO NUMBERED LINES ON THIS DIAGRAM

LINE NO.	DESCRIPTION
101	Posting of items 1,2,3,4,6,7,8,11,16,18 from Batch Ticket 'A' to Daily Production Report 'C' Posting to be throughout the day as Batch Tickets are received.
102	Posting of items 5, 9, 13, 15, 23, from Standard Formula Record 'B' to Daily Production Record 'C' Posting to be done throughout the day as promptly as Batch Tickets are received.
103	Posting of items 1, 6, 8, 11, 18 from Batch Ticket 'A' to re-arranged Standard Formula Record 'B-1' Posting to be done at the same time the Batch Ticket is entered on Daily Production Record 'C'
104	Posting totals of items 6, 10, 11, 14, 18 to 20, 21, 22, 23, 24, shown on Daily Production Record 'C' to Monthly Summary 'D'. Posting to be done on following day
105	Posting monthly totals of items 10, 14 from Monthly Summary 'D' to Milling cost Ledger Sheet 'E' Posting to be done first day of the following month.
106	Posting 16, 21-22, from Monthly Summary 'D' to Mixing Cost Ledger Sheet 'F' Posting to be done the first day of next Month.

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MANAGEMENT ENGINEERS

Serial No.

FIG. 87A. ILLUSTRATIVE PROCEDURE OF RECORDING COSTS IN THE MANUFACTURE OF PRINTERS' INK (Section I)

COMPILATION OF EXPENSES

MONTHLY EXPENSE VOUCHER — Brooklyn FACTORY — July 31, 1927

DATE	IN FAVOR OF	CHEQUE #	BUDGET $ AMOUNT	CODE A $ AMOUNT	BUILDING E $ AMOUNT	CRUCIBLE G $ AMOUNT	BOILERS H $ AMOUNT	POWER I $ AMOUNT	MACHINE M $ AMOUNT	MACHINE N $ AMOUNT	MACHINE O $ AMOUNT	MACHINE Q $ AMOUNT	VOUCHER S $ AMOUNT	
	Brooklyn Edison Co.	5672						1000.00						1000.00
	City Water	3			45.00	55.00	115.00	150.00	160.00	215.00	387.50	275.00		1257.50
	Total Power Dept	4									50.00			50.00
	City Light Dept	5			25.00									25.00
	City Transportation Co.	6	250.00											250.00
	Edison Car Collector	7		1300.00										1300.00
	Coal Co. Virginia	8			25.00									25.00
	City Light Dept	9			45.00	30.00	115.00	145.00	160.00	200.00	400.00	275.00		1370.00
	Electric Contractors Co.	5600								25.00				25.00
	Power Engineering Co.	1									15.00			15.00
	Diesel Engine Supplies	2			75.00									75.00
	Coal Coal Contract Co.	3			30.00									30.00
	Power Supplies Co.	4									50.00			50.00
	Power Engineering Co.	5			25.00									25.00
	Coal Co. Virginia	6												100.00
	City Water Service	7	15.00		30.00		30.00		10.00			15.00		100.00
	etc	8												
	etc	9												
	etc	5600												
	etc	1												
	Total	93	1600.00	3080.00	7900.00	755.00	535.00	1600.00	715.00	1035.00	1660.00	1175.00		19745.00
	Summary of Distribution		250.00	1300.00	1660.00	785.00	680.00	1745.00	875.00	1235.00	2060.00	1450.00		21040.00
			1350.00		6240.00	30.00	55.00	145.00	160.00	200.00	400.00	275.00		8855.00
			1600.00		7900.00	815.00	735.00	1890.00	1035.00	1435.00	2460.00	1725.00		29895.00
			183.50											
			1600.00	3080.00	7900.00	755.00	535.00	1600.00	715.00	1035.00	1660.00	1175.00		19745.00

MONTHLY EXPENSE VOUCHER. ENTER DISTRIBUTION OF EACH CHEQUE ACCORDING TO CHART OF ACCOUNTS. MAKE FORM "G" IN DUPLICATE, ONE COPY SENT TO NEW YORK OFFICE.

Balance on hand July 1 1927 $ 1245.00
Received to August 15th 1927 1500.00
Less Disbursements as above 1354.00
Balance on hand July 31 1927 1391.00

MILLING COST LEDGER SHEET. ENTER STANDARD CREDITS FOR MONTH'S PRODUCTION TOGETHER WITH ODD LOT LOSSES OBTAINED FROM MONTHLY SUMMARY. (LINE 103.)

MILLING BROOKLYN 1927

		BUDGET YEAR	BUDGET MONTH	JAN MONTH	JAN TO DATE	JULY MONTH	JULY TO DATE
1	PAYROLL	24,000.00	2,000.00	3,300.00		3,300.00	21,600.00
2	REPAIRS & SUPPLIES	2,400.00	200.00	150.00		250.00	2,000.00
3	SUNDRY EXPENSE	1,200.00	100.00	75.00		150.00	1,000.00
4	RENT	2,400.00	200.00	200.00		200.00	1,400.00
5	FIXED CHARGES	2,400.00	200.00	150.00		100.00	1,250.00
6	COMPENSATION INSURANCE	240.00	20.00	20.00		22.00	160.00
7	POWER	15,000.00	1,250.00	1250.00		1259.00	8,758.00
8							
9	LABORATORY & MATCHING						
10	GENERAL FACTORY	60,000.00	5,000.00	5,000.00		5,000.00	35,000.00
11							
12							
13	TOTAL ACTUAL EXPENSE			10,445.00		10,230.00	70,968.00
14	TOTAL BUDGET EXPENSE	114,240.00	9,520.00				
15	BUDGET MILL HOURS	40,000 Hrs.	3333 Hrs.				
16	STANDARD COST PER MILL HR	2.85					
17							
18	STANDARD HOURS EARNED			4,000.00		3,900.00	23,000.00
19	STANDARD ALLOWANCE FOR MILL EARNING			11,225.00		11,200.00	65,550.00
20	ODD LOT LOSS HOURS			180.00		200.00	2,500.00
21	ODD LOT LOSS ALLOWANCE			275.00		300.00	1,750.00
22	TOTAL STANDARD & ODD LOT			11,500.00		11,500.00	67,300.00
23	ACTUAL EXPENSE ABOVE			10,445.00		10,230.00	70,968.00
24	GAIN OR LOSS			+ 1055.00		+ 1270.00	- 3,668.00
25							
26	LABOR						
27	BUDGET PAYROLL	24,000.00					
28	BUDGET LABOR HOURS	20,000 Hrs.					
29	STANDARD LABOR HOUR COST	1.200					
30	STANDARD LABOR HOURS EARNED			2,000.00		2,000.00	12,000.00
31	STANDARD ALLOWANCE FOR MILL EARNED			$ 2,250.00		$ 2,340.00	$ 13,500.00
32	ACTUAL LABOR ABOVE			2,400.00		2,400.00	14,400.00
33	GAIN OR LOSS			- 150.00		- 60.00	- 900.00

MILLING BROOKLYN 1927

		BUDGET YEAR	BUDGET MONTH	JAN MONTH	JAN TO DATE	JULY MONTH	JULY TO DATE
1	PAYROLL	9,600	800	250		300	3,000
2	REPAIRS & SUPPLIES	600	50	-		70	525
3	SUNDRY EXPENSE	600	50	-		60	375
4	RENT	600	50	50		50	350
5	FIXED CHARGES	1200	100	100		100	700
6	COMPENSATION INSURANCE	60	5	5		5	35
7	POWER	1200	100	100		100	700
8							
9	LABORATORY & MATCHING	1800	150	150		150	1050
10	GENERAL FACTORY	24,000	2,000	2,000		2,000	14,000
11				3,155		3,035	21,735
12							
13	TOTAL BUDGET EXPENSE	39,660.00	3,305.00				
14	BUDGET PRODUCTION A	40,000	3,333 Hrs.				
15	NUMBER OF B	4000	333				
16	MILES C	3600	300				
17							
18	COST PER MIL A	1.00 M					
19	B	10.00					
20	C	22.00					
21							
22	ACTUAL NUMBER OF MILES A			4000		3900	23,000
23	B			400		390	2300
24	C			360		351	2070
25							
26	STANDARD ALLOWANCE FOR			3,760.00		3,666.00	21,735.00
27	ACTUAL NUMBER OF MILES			3,760.00		3,666.00	21,735.00
28	ODD LOT ALLOWANCE			+ 121.00		+ 144.00	+ 1,000.00
29	TOTAL STANDARD & ODD LOT			3,881.00		3,810.00	22,735.00
30	ACTUAL MILLING EXPENSE			3,155.00		3,035.00	21,735.00
31	GAIN OR LOSS			+ 726.00		+ 775.00	+ 1,000.00

MILLING COST LEDGER SHEET. ENTER STANDARD CREDITS FOR THE NUMBER OF MILES PRODUCED THIS MONTH TOGETHER WITH ODD LOT LOSSES OBTAINED FROM MONTHLY SUMMARY. (LINE 108.)

DETAIL STATEMENT OF OPERATING PROFIT AND LOSS

FOR July, 1927.

Operating Center	Per Cent Activity	Actual Cost Unit	Actual Cost Total	Standard Cost Unit	Standard Cost Total	Gain, Loss.
General Factory E						
Drums S						
Building N						
Power I						
Laboratory & Matching M			3440.00		3945.00	505.00
					+ 30.00	
Mixing K Odd Lot Loss						
Milling O	83⅓		10120.00		14,397.00	4277.00
Odd Lot Loss					- 397.00	
Varnish Q						
Total						

THIS STATEMENT IS MADE UP IN DUPLICATES. ONE COPY BEING SENT TO THE NEW YORK OFFICE.

KEY TO NUMBERED LINES ON THIS DIAGRAM

LINE NO.	DESCRIPTION.
107	Posting of current expenses from Column G, Summary of Distribution, on Form "G" to Milling Cost Ledger Sheet "E."
108	Posting of Current Expenses from Column N, Summary of Distribution, on Form "G" to Mixing Cost Ledger Sheet "F."
109	Posting of actual cost, standard cost, gain or loss from Cost Ledger Sheets to the Detail Statement of Operating Profit & Loss. Form "H"

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THE STEVENSON COMP. OF BOSTON HARRISON
J. W. JORDAN & ASSOCIATES
MANAGEMENT ENGINEERS

Serial No.

FIG. 87B. ILLUSTRATIVE PROCEDURE OF RECORDING COSTS IN THE MANUFACTURE OF PRINTERS' INK (Section 2)

ance in terms of cost and of checking actual performance against standards by elements of cost.

Illustrative Procedure of Recording Costs.[1] A standard formula record (B), Figure 87, is maintained in the planning department showing the ingredients which will mix a standard size batch of ink in a standard time on a size mill which is taken as standard for that class of ink. Briefly every condition necessary to produce the greatest amount of ink per hundred pounds is listed on this standard formula record which forms a specification for the product. The cost routine is as follows:

1. The batch ticket (A) is copied from the standard formula record in the planning department and sent to the mixer who weighs the formula. On this batch ticket conditions under which the standard is set are copied so that the foreman can see that these conditions will be duplicated at the time of doing the work.

2. The time at the start and at the completion of the work is stamped on the batch ticket, and it is then forwarded to the production clerk. He enters the production yield in pounds, standard time allowed for this yield, and actual time taken on the daily production report (C). Should the actual time take longer than the standard the foreman notes on the batch ticket the reason for it. This reason is reviewed by the superintendent.

3. At the end of the day a summary is made of the standard hours earned by each type of machine and by each department. This is a total of the standard time allowance for each formula produced. The actual hours are compiled alongside of these for comparison and analysis, in whatever detail is required. All totals of hours worked, allowed, lost, etc., are recorded on a summary form (D).

4. At the end of the month the standard hours earned by each department are entered on the cost-ledger-sheet form and analyzed for lost time and their causes as will be subsequently shown.

5. The standard hours earned for each size mill are extended by the standard mill-hour rate to obtain the standard cost of the month's production for that group of machines or department. This is what we figured it should cost at standard efficiency. The department cost ledger sheet (E) (F) is credited with this standard cost just as if the ink was bought from an outside concern at a contract price.

6. Through a voucher register (G) distribute actual current expenses for the month to the cost ledger accounts (E) (F). This compares them item for item with the budget.

7. The total actual expenses of the department are obtained. If these expenses amounted to $14,500 for the month of February and the standard cost of the ink produced by all machines this month is

[1] The business taken for illustration is the manufacture of printers' ink.

only $10,500, there is a $4,000 loss in the department to be analyzed and accounted for in specific detail.

Analyzing Variations from Standards. To compare departments on a basis of dollars expended only is dangerous, because it tends to make a department head concentrate on lowering total expenses when he might be able to reduce the cost of production 50 per cent with an increase in expenses of only 10 per cent. Under standard costs a department head is allowed a budgeted amount for every unit of goods produced or sold, based on very accurate research into the setting of this standard of expenses and activity.

The individual and general expenses of a similar nature have been collected and distributed to departments based on the cause of these expenses. Each department should be compared on a basis of its own activity. Certain distributed expenses of a general nature must be segregated or else a department head will be held accountable for something over which he has no control. The administrative expenses must be compared with the work involved in the general office, such as orders entered, billed and extended. Likewise, selling expenses for the branches and districts must be compared with the sales quota and gross sales obtained for these branches and districts. General sales office expenses should not enter the picture. The general sales manager is accountable for these expenses and not the branch manager.

The daily production report and its summary have collected the time lost from various causes as follows:[1]

1. *Loss Due to Productive Inefficiency.*

Actual hours worked	13,000
Standard hours earned	10,500
Loss in manufacturing	2,500 hours or $2,500

Which is further analyzed as follows:

Faulty planning	300 hours
Breakdowns	200 hours
Failure to produce at standard rate	2,000 hours
Total	2,500 hours

[1] In the accompanying illustration, we have used $1.00 per hour as the costing rate in order to simplify matters. The amount of labor and overhead expense which can be charged to the various departments for lost time, of course, varies. There are some industries where even the labor force cannot be cut down with a decrease in volume because only a few men are required under any conditions. For example, the manufacture of prime chemicals such as sulphuric acid, etc. On the other hand, there are some industries where the labor force and some of the overhead expense items can be materially changed with any fluctuation in volume. Therefore, the hours lost through the various causes must be extended by a cost per hour which reflects only the amount of expense which could have been reduced. To explain how this fixed and variable expense per hour is obtained would itself take an article as long as this one.

This loss and its cause have already been traced down to the product, machine, and men responsible, by the superintendent at the end of the day when he reviewed the daily report. Therefore the monthly summary for the works manager can include a further refinement of each of these variations, down to their exact cause, such as: using wrong size machine, substandard worker, poor quality material, odd lot, rush order or poor stock control.

COST LEDGER SHEET

CONTROLLABLE ITEMS	Budget Year	Budget Month	Jan. Month	Feb. Month	Year to Date
Supplies	$ 12,000	$ 1,000	$ 900	$ 850	$ 1,750
Repairs	3,000	250	225	300	525
Payroll—indirect labor	24,000	2,000	2,000	1,800	3,800
direct labor	96,000	3,000	3,100	7,150	10,250
Share—Maintenance	6,000	500	550	600	1,150
—Power	10,200	850	800	700	1,500
—Compensation Ins.	300	25	25	25	50
Sub-total	$151,500	$12,625	$8,605	$11,425	$19,025
UNCONTROLLABLE ITEMS					
Share—Building Expense	$ 4,800	400	400	400	800
—Taxes, Insurance Depreciation and Interest on Investment	16,500	1,375	1,375	1,375	2,750
—Laboratory	1,200	100	150	200	350
—General Expense	6,000	500	700	1,100	1,800
Sub-total	28,500	2,375	2,625	3,075	5,700
Total	$180,000	$15,000			
Normal No. of Hours worked	180,000	15,000			
Standard Cost per hour		$1.00			
Standard Hours Earned			12,000	10,500	22,500
Total Actual Cost			$11,230	$14,500	$25,730
Total Standard Cost Allowed			12,000	10,500	22,500
Gain or Loss			770	4,000	3,230
Hours Lost Due to					
Productive Efficiency		Gain	1,400	2,000	600
Repairs and Planning			−200	500	700
Lack of Sales			−3,000	4,500	5,000
Difference in Expense					
Controllable Items			+$4,020	+$1,200	+$5,220
Uncontrollable Items			−300	−700	−1,000

FIG. 88. ILLUSTRATIVE COST LEDGER SHEET

2. *Loss Due to Lack of Volume.* Assume that the sales department has agreed to keep the plant producing at 80 per cent capacity, or 15,000 standard machine hours of work.

Standard hours (normal sales)	15,000
Standard hours worked	10,500
Loss in hours due to lack of sales	4,500 hours or $4,500

3. *Loss Due to Variation in Expense.*

Actual expenses	$14,500.00
Budget expense	15,000.00
Decrease in expense over budget	$ 500.00

An examination of the cost ledger sheet (Figure 88) shows that controllable items have decreased $1,200, while distributed general expenses that are uncontrollable as far as the factory is concerned, have increased $700, leaving a net of $500.

Departmental Summary. A form can be drawn up, summarizing a month's operation for Department A as follows:

Losses

Failure to produce at standard rate		$2,000.00
Due to substandard worker		
On piece work	$ 219.55	
On day work	1,655.25	
Due to small lots	110.30	
Due to poor materials	14.90	
Faulty planning		300.00
Due to wrong size machine	81.70	
Due to poor stock control	none	
Due to incorrect delivery promise	218.30	
Breakdowns (increase above budget)		200.00
Machines No. 61 and No. 68 special repairs	175.00	
Ordinary maintenance	25.00	
Lack of sales volume		4,500.00
Fixed and general expense		700.00
Due to lack of volume	625.00	
Due to raise in salaries	50.00	
Miscellaneous increases	25.00	

Gains

Decrease in controllable expense		1,200.00
Due to layoff because of lack of volume	1,050.00	
Due to lower power cost	150.00	

Analysis of sales expense

Increase over standard allowance: $9,854.41

Due to quotas		
Loss—Failure to reach quotas		$8,124.63
District 1	$3,841.22	
2	1,301.07	
5	2,511.61	
7	370.83	
Gain—Exceeded quotas		2,606.28
District 3	641.52	
4	1,728.14	
6	236.62	
Due to increased expense over budget		3,614.22
Turnover of salesmen	1,824.16	
Auto expense	70.06	
Entertainment	422.00	
Special campaigns, exhibits	1,208.00	

All of these expenses could be traced to any district also if desired:

Due to general selling expense—increase over budget....		721.84
Fixed salaries and charges.....	100.00	
New designs.....	418.77	
Advertising appropriation.....	203.07	

With such a comparison and accurate set standards, a company is bound to progress. The standards of production, sales and expense are fair measures of the task expected from each executive by the management. With each executive taking full responsibility to better these standards and compensated according to results, a live energetic organization is certain to result.

Variations in Material Costs. In the make-up of a standard or budget cost of a product, all materials are priced at a standard price per unit, so the first step in material cost procedure is to reduce all materials purchased from an actual to a standard price per unit.

Variation in Purchase Price. Variation in purchase price is obtained as follows:

1. The invoice as rendered by the vender represents the actual cost of the purchase. This invoice is priced at the standard price for the raw material covered by the invoice and extended by the actual quantity noted thereon. This will give the standard cost of the materials purchased.

2. The actual cost and the standard cost of the month's purchases are recorded and totaled. The difference between the actual cost and the standard cost is debited or credited in purchasing gain or loss account. This purchasing gain or loss account serves the purpose of calling to the attention of the management any variation in the raw-material market price.

Variation in Material Consumed. The standard cost of the formula is based on a standard quantity of each raw material at its standard price. The difference in quantity actually used must be obtained, according to the following procedure:

1. The production order and requisition notes any raw material additions to the standard formula. As these additions are few in number so only the additions are priced at their standard unit price, rather than repricing every ingredient in the formula. The total cost of excess material used on that batch is added to the standard material cost to give the actual cost of material consumed. It is copied on a material recapitulation sheet.

2. The standard cost of raw material consumed for the actual yield is obtained on the daily production record (Figure 89) by multiplying the actual yield by the standard cost of material per pound for that

DEPARTMENT GAIN OR LOSS REPORT

for

February, 1926

Operating Center	Common Unit	Budgeted Number of Units	Actual Number of Units	Per cent Activity	Actual Costs Labor Overhead	Standard Costs Labor Overhead	Gain Labor Overhead	Loss Labor Overhead	Remarks

FIG. 89. COLUMN HEADINGS OF DEPARTMENT GAIN OR LOSS REPORT

formula. This is what the cost of material for that yield should have been if standard quantities had been used. It is copied on the material recapitulation sheet alongside of the actual material cost for the batch.

By subtracting total cost of actual material requisitioned from the standard quantities, the material consumed gain or loss is obtained. The purchasing gain or loss account, as previously mentioned, shows how much variance there is because of price fluctuations, and the material-consumed gain or loss account shows how much is due to quantity fluctuations. It is a check on the standard allowance on waste.

Further check on this waste factor is obtained at annual inventory taking as the book value and actual count value at standard price should agree. Any unreasonable variation is due to physical loss and not to price, as both inventories have been priced at standard.

Operating Statement. The summary of the business as a whole is made through the operating statement (Figure 90). This form compares budget and actual expenses of the departments with the budgets of production, sales, or whatever the activity in which the department is engaged. This statement is for the chief operating executive and points to the analysis of certain cost ledger sheets which demand his immediate attention.

Profit-and-Loss Statement. 1. This statement is an aid to the effectiveness of any unit of the management. The condition of the business as a whole is pictured in the profit-and-loss statement which carries out the principle of standard cost by comparing the budget of each of the major divisions of the business with actual results. It is the means of tying up the major executives to their tasks of creating profits to the company. It is not a bare statement of expenses with a final result for the period. It compares final results with expected results or standard.

2. The sales manager is judged by the amount of mark-up or standard profit. This standard profit is the difference between the standard cost of the goods sold and their sales price. Manufacturing inefficiencies, advances in material prices or material consumption, do not enter this section of the profit-and-loss statement. The sales manager is solely in control of the function of pricing and his efforts can be judged by the standard profit. He is also responsible for the effective use of the sales department. If the sales are planned correctly he will not only increase sales profits because of price but also because of decrease in selling cost per dollar of sales.

3. The purchasing agent is responsible for watching the supply markets. The effectiveness of his work in obtaining favorable contracts reflects itself in lower prices over standard material costs. While much of this is the result of market conditions, his alertness in

forecasting trends can be seen from analysis of the material gain or loss accounts on the statement. This section of the profit-and-loss statement has a further significance. As material prices advance the general executive or the sales manager can increase prices of the finished products to a limited extent. Conversely, if the market is going

PROFIT-AND-LOSS STATEMENT

February, 1928

	MONTH		YEAR TO DATE		INCREASE		DECREASE	
	Budget	Actual	Budget	Actual	Amount	Per Cent	Amount	Per Cent
Gross Sales								
Less Returns and Allowances								
Net Sales								
Std. Mfg. Cost of Sales								
Std. Administration Exp.								
Std. Selling Expense								
Std. Profit and Loss								
Operating Gain or Loss								
Actual Mfg. Expense								
Std. Mfg. Expense								
Gain								
Actual Adm. Expense								
Std. Mfg. Expense								
Loss								
Actual Selling Expense								
Std. Selling Expense								
Gain								
Actual Material Cost								
Std. Material Cost								
Gain								
Net Results								

Fig. 90. Operating Statement for the Chief Executive

down he may have to meet lowering of prices by the trade. The condition of inventories on hand and the gain or loss in purchases during the last month are valuable guides for determining whether the company can lead the field in an increase of price over competitors.

4. Another section reflects whether the administrative budget has been adhered to and whether the sales have altered the work of the office force. An increase in orders per dollar of sales is a handicap to the office manager in effective handling of the office staff.

5. The works manager is judged by the gain or loss in the manufacturing expense which is the summarizing account for the manufacturing departments.

In explaining standard costs this chapter develops each of these operating and financial statements from the manufacturing and sales departments where the detail is collected. However, the chief executive would work backwards; *i.e.,* the profit-and-loss statement would be shown him first. From the profit-and-loss statement he would decide what main part of the organization is falling from standard, and concentrate his attention there by referring to the operating statement. The operating statement would point to the division which is contributing to the loss, and a review of the cost ledger sheet for that department would point at once to the cause.

Should the management standards be improved in all divisions, the chief executive would feel satisfied in leaving the operation of the business to his major executives. This would enable him to devote his entire time to the further improvement of the company and to improving conditions in the whole industry and kindred industries. Much of his time would be taken up in policy making and a great deal of it in trade association activities to better conditions in the industry and in those of the industries served.

Standard Costs as a Basis of Executive Bonus. Reward and compensation have been referred to often in this discussion of the use of standard cost for control and fixing responsibility. It is possible to use it as a basis for wage incentives only when the standards have been set by careful research into all factors by a disinterested staff. The research methods to be used have been described in other chapters of this book.

The production standards for the direct and some of the indirect labor, must be set by time study if this labor is to be compensated on a piece-work or bonus basis. The foreman's bonus is based on a standard allowance of controllable items of expense for each standard productive unit. The superintendent's bonus is made up in a similar manner. The salesman's bonus is based on his sales quota and allowable sales expense. The branch manager is paid likewise, on the basis of results in his branch. All major executives share in profits in proportion to the manner in which they influence these profits. The exact details of all of these suggestions for bonuses must be worked out for the individual company. But the goal is set up by standard costs for all workers and their cooperation is well rewarded.

Tie-In with General Ledger. While control through inspection and measurement of effort is the main function of any cost system, a cost system must be tied in to the general books if accuracy in obtain-

ing a financial statement is desired. The standard cost system is tied into the general ledger accounts through the medium of controlling accounts for the various department cost ledger sheets. The major details are briefly as follows:

1. The voucher register is divided into sections, one section for each controlling account. This section may be a column or a page as is shown in Figure 87 (G). As previously mentioned current expenses are distributed to their respective cost ledger sheets through a voucher register.

The totals of these distributions in each section of the voucher register are debited to its respective controlling account. This charges into the general ledger the total distribution of current expenses to the cost ledger, and charges the month's purchases into the inventory accounts.

2. The monthly charges for such periodic expenses as taxes and insurance included in costs are credited to their respective reserve accounts in the general ledger by journal entries (Figure 87 G). In order to complete the month's cost to determine profit or loss, journal entries are put through covering inventories used during the month, cost of sales, and sales for the month, in the usual manner of closing out the books of account for the month.

This greatly simplifies the routine of general ledger bookkeeping and the taking off of a trial balance, since the general ledger is not filled with too many accounts and with a multitude of detail. It also gives a check on the cost work, as the total balance in the subsidiary cost ledger accounts should equal the one balance in its corresponding controlling account in the general ledger.

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Cf. also references to Chapter XIX.

PART VI

HUMAN ASPECTS

If the world someday becomes so rich, and so happily organized, that favorable living conditions can be provided for everyone, it is certain that a large part of the meanness which now reigns will be wiped out; with regard to this point, historic materialism is in the right.—Count Hermann Keyserling.

Modern technology is highly spiritual because it seeks, through human ingenuity and intelligence, to relieve human energy from the unnecessary hardships of life and provide for it the necessary conditions for the enjoyment of life. Whatever be the use man may make of the resultant comfort and leisure, the relief of suffering and hardship is in itself spiritual.—Hu Shih.

. . . It is often alleged that, great as has been the workman's advance in material well-being and political status, and even in intellectual attainments, he has lost, by the coming of the Machine Age, his joy and freedom in production, and even his artistic capacity. . . . Is this soulless Robot, we are asked, any advance on Giotto or Cellini? Needless to say, the contrast is illegitimate. . . . From the building of the pyramids down to the present day, the proportion of the world's work of the nature of mere physical digging, pushing, carrying, lifting, and hammering, by the exertion of muscular force, has almost continuously diminished. . . . In the machine industry the development among the superior minority takes what may be called an intellectual rather than an artistic form. Its product is exact thinking, calculation, adjusting, fitting. Yet is not this art? . . . It is, indeed, to the so-called unskilled workers . . . —and notably to their wives and children—that the Machine Age has incidentally brought the greatest advance in freedom and in civilization.—Sidney and Beatrice Webb.

To enjoy the property of his job—to partake of all the individual and social recognitions which can come from it in the way of opportunity and security—here is the very kernel of the worker's heart's-bottom wish of his work. To obtain the maximum of freedom for showing what manner of man he is by the nature of his handiwork, and to enjoy the maximum of certainty and permanency in the satisfactions of the status and recognition which his craftsmanship has obtained for him—this is the requirement which he puts daily upon himself and so upon his method of earning his family's daily bread. —Whiting Williams.

We do not find that "labor" wants participation in the responsibilities of ownership or management. . . . What we find that labor wants, as a class, is wages, hours, and security, without financial responsibility, but with power enough to command respect. . . . If we are right in this . . . then so much the greater is the opportunity and responsibility of management. . . . Management, then, becomes responsible, not only to the stockholders, but also to the workers and the nation.—John Commons.

CHAPTER XXVII

LEADERSHIP IN SCIENTIFIC MANAGEMENT[1]

A STATEMENT in the first chapter has by now become more significant to the reader: that scientific management is *not* an inflexible system of procedures which can be bought and installed like a boiler or a loom, but is something of an organic nature which is developed out of a harmony of desires and understandings within an organization through the guidance of an outstanding leadership.

Attempts to develop scientific management have in general been successful in direct proportion to the degree to which those who have initiated and directed its development have possessed genuine qualities of leadership. And the failures attributed to scientific management have generally been failures of leadership in initiating and guiding its development, particularly the order, rate and extent of development.

The first conspicuous weakness of leadership in this respect may be failure to realize that there is involved the problem of integrating radically different types of executives in an organization where the mental attitudes and habits have originally been dominated and set by one particular type. We know of no instance in which an enterprise has been *started* with the ideal of application of the Taylor principles and an original executive staff designed for that purpose. That ideal usually comes later with a problem of reorganization to meet new and sometimes embarrassing industrial conditions. Those executives who start such an enterprise are usually of the promoter type, interested primarily in promoters' profits, or enhancement of the capitalized putative valuation of the enterprise, and only secondarily in current income from technical processing. Neither temperament nor motive incline them to be interested in the details involved in operating procedures. In case they are not "operating" executives in the strictest sense of the word, their associated operating executives are almost certain to be what has come to be known as the go-getter type so characteristic of frontier industry and a sellers' market. It is this promoter and go-getter type of executive which usually dominates an enterprise in its early years and determines mental attitudes and practices. With the introduction of scientific management, however, there arises the necessity of introducing into such an organization a new type of executive, interested in designing a precise and waste-saving system of interlock-

[1] By H. S. Person, Managing Director of the Taylor Society, New York.

ing methods or in directing operations in accordance with a sympathetic understanding of such a system.

The writer has elsewhere called attention to the distinction between the promoter type and the engineering type of executives:

> The long sellers' market of the United States has developed highly one particular type of executive—the forceful, acquisitive, go-getter type which drives straight to results regardless of methods and cost. But while the forceful, go-getter type of executive will always be essential, managers have come to realize that an organization must be balanced by the inclusion of the thinking, investigating, planning type of executive who surveys conditions and tendencies, formulates precise plans, establishes schedules and budgets, keeps departments co-ordinated, maintains precise control of operations, has regard for efficiency and economy of methods, and all the time appraises progress and results in terms of plans. Even the go-getter executive, so useful in the early days of an enterprise, must become a thinking, planning executive after the enterprise is well established as a going concern.[1]

John E. Otterson has made much the same distinction, using a different terminology:

> The engineering type of man works for the solution of a single technical or engineering problem and is concerned with the determination of the solution rather than the application of that solution to practical activities. The true type has the capacity to concentrate continuously on a single problem until the solution has been reached. He is interested in the determination of cause and effect and of the laws that govern phenomena. He is disposed to be logical, analytical, studious, synthetical, and to have an investigating turn of mind. The predominating characteristic that distinguishes him from the executive is his ability to concentrate on one problem to the exclusion of others for a protracted period, to become absorbed in that problem and to free his mind of the cares of other problems. He does not submit readily to the routine performance of a given amount of work. He deals with laws and abstract facts. He works from text books and original sources of information. Such men are Edison, Steinmetz, the Wright Brothers, Curtiss, Bell, Pupin, Fessenden, Browning. These men are the extreme of the engineering type; they have enormous imagination, initiative, constructive powers. Mr. Taylor was in reality an engineer rather than an executive. He applied his wonderful inventive genius to the invention of management methods.
>
> The executive type takes the conclusions of the engineer and the laws developed by the engineer and applies them to the multitude of practical problems that come before him. His chief characteristic is that he works with a multitude of constantly changing problems at one time. He concentrates on one problem after another in rapid succession. In many instances he has not the time to obtain all of the facts and he must arrive at a conclusion or make a decision based upon partial knowledge. He must rapidly assimilate available facts and fill in what is lacking from the ripeness of his own experience, frequently calling on his powers of judgment, and even of intuition. He is a man of action, boldness, ingenuity, force, determination, aggressiveness, courage, decision; he is possessed with the desire to get things done, impatient of

[1] *Bulletin of the Taylor Society*, Vol. VII, No. 6, December, 1922, p. 217.

delay. He works from a handbook, a newspaper, or nothing at all. Such men are Schwab, Goethals, Pershing, Farrell, Hindenburg, Hoover.

We frequently find that the leaders of either of these classifications possess something of the qualities of both and therefore we have executive engineers and engineering executives. The combination of a high order of ability in these two classes in a single individual is rare and valuable.[1]

In still a different terminology John Williams has made a similar distinction:

The science of management, as I see it, has to do with the determination of the facts concerning the design, selection and operation of means to a given end—in other words, the facts bearing upon a problem of management; whereas management—whether systematic or scientific, whether of a manufacturing or merchandising business, whether of an institution or a government—if it is *management,* and not the *science of management,* is primarily concerned with expediency and leadership, however much it may be tempered by science or system. . . . The science of management, or management as a branch of engineering, which I believe to be a more desirable term, should be used by both managers and administrators to determine the facts upon which their policies and decisions are based, but its function as such should stop where the determination of facts ends and expediency begins . . . there will always be a plane on which the final determination must include things other than facts . . . management as a science or branch of engineering has hardly gone further than to deal with the mechanics of management, and it is not to be wondered that executives with broad and varied experience in management and administration, in their larger aspects of policies and personalities, resent the sometimes all-embracing counsels of those whose experience is largely confined to the mechanisms of management.[2]

Whatever classification and terminology of differences one may use, the fact should be recognized that the development of scientific management first of all compels the rebuilding of the executive group so that it shall represent a proper balance of these types working together sympathetically and understandingly for a common purpose.

Frequently after it is realized that scientific management requires the introduction of a new type of executive into the organization, the nature of the basic problem of integration may not be realized. A second weakness in conventional leadership may be failure to recognize that the harmonizing of these types of executives involves the breaking down of well-established organization habits and the building up of new executive habits. An enterprise which has become well established as a going concern is a group of executives (in this chapter we disregard the workers, who are not the principal obstacle to the undertaking of improvement in management) of whom each represents a particular bundle of capacities, aptitudes, habits, preju-

[1] *Annals of the American Academy of Political and Social Science,* September, 1919, pp. 91-92.

[2] *Bulletin of the Taylor Society,* Vol. IX, No. 2, April, 1924, p. 67.

dices, inhibitions and complexes. And out of the association of such a group has emerged an institutional pattern of executive habits and prejudices. It is no small matter to introduce a new type of executive and evolve (to create is impossible) in the reorganized group a new integration of habit relationships.

Executives are temperamentally resistant to change. Under the conditions of industrial development in the United States, generally executives have acquired their positions either because of family inheritance or because of personal strength and individuality. The former usually favor inherited methods as opposed to the new; the latter usually are prejudiced against that which they have not themselves created. James Mapes Dodge many years ago called attention to this practical fact of executive inflexibility:

> We will therefore assume that it has become the desire of a general manager to introduce scientific management into his establishment. The first step, even though he is the sole proprietor and theoretically can do exactly as he pleases, must of necessity be to interest some of his associates. This he will find, as I have previously stated, is not in every case an easy proposition, for the reason that temperamental differences in individuals will require varying degrees and kinds of explanations, and the setting forth of the reasons in different mentally palatable ways. He will of course find, when he approaches his subordinates and they in various degrees accept his views with the feeling that something can be done of advantage to the establishment, that in no case will his leading men consider that anything in this new-fangled management business should be in any way applied to them, though they can see with greater or less degree of certainty that it would be admirable for everybody else in the place. The problem of overcoming this mental condition is the most difficult of all. The very fact that the leading men of an establishment are beholden to their cleverness and independence of thought for their promotion makes it certain that they will not hesitate to combat the views of their superior, if in their judgment it seems best.[1]

A third failure in leadership may be inability to recognize and harmonize two types of functions that continue to exist, although in new proportion, even in a scientific management plant: the function of directing controllable operations, and that of directing uncontrollable operations. In the field of general executive responsibility, as distinguished from the direction of processing of physical materials, there remains a large area of the unknown and unexpected—changes in industrial conditions, interest rates, market conditions, volume of orders, and so on. Decisions concerning problems arising out of changes in these factors sometimes have to be made quickly, sometimes have far-reaching consequences, and sometimes upset the smooth-

[1] "The Spirit in which Scientific Management Should be Approached," in *Addresses and Discussions at the Conference on Scientific Management*, (October, 1911) Amos Tuck School of Administration and Finance, Dartmouth College, Hanover, New Hampshire, 1912, p. 149.

ness of controllable operations being conducted in accordance with plans based on assumptions (for instance, the volume of orders) which are no longer correct. Failure to provide for a harmonizing of these contradictory situations may result in misunderstandings, irritations, loss of sympathy and perhaps even ill will. Failure to promote the new interests would surely follow.

A fourth weakness of leadership in scientific management may be failure to realize that the development of the system of procedures is a problem of discovering and creating something new—something in its general structure identical with other developments of scientific management but in its details and in the emphasis on one or another element peculiar to the particular managerial situations. "Scientific management is not any efficiency device, not a device of any kind for securing efficiency; nor is it any bunch or group of efficiency devices";[1] by which Taylor meant not only that the attitude of mind is more important than the procedures, but also that there is no one system of procedures which, ready-made, can be installed in any managerial situation. "There is not one who uses the same methods in any two successive establishments,"[2] wrote Taylor to an officer of the navy. The scope and the rate of development, the particular combination of mechanisms, and the precise nature and emphasis of each must be determined by the particular circumstances. And among these circumstances is the capacity for constructive contribution as well as for reception of new ideas by each member of the organization.

A fifth failure of leadership may be absence of appreciation that the development of scientific management is an *educational* process. The integration of various types of executives, the elimination of old patterns of habit by understanding practice of the new, the adjustment of the controllable and the uncontrollable, the stimulation of common constructive effort in devising the new procedures, and particularly, the gradual development of that understanding and sympathetic appreciation without which all else is impossible, must be the result of truly educational processes. These cannot be achieved by fiat. The various devices of a system are but objective manifestations of common desires, purposes and understandings. Just as the area and rate of the development of procedures must fit the particular circumstances, among which are the human factors; so also the human factors of understanding and sympathy must be developed to permit an ever wider area and accelerated rate of development of mechanisms. And the

[1] Taylor, Frederick W. "Testimony Before a Special Committee of the House of Representatives, 1912," reprinted in *Bulletin of the Taylor Society,* Vol. XI, Nos. 3 and 4, June-August, 1926, p. 102.

[2] Copley, Frank Barkley, *Frederick W. Taylor: Father of Scientific Management,* New York, Harper & Brothers, 1923, Vol. II, p. 309.

educational technique cannot be that of the birch rod, but must be that of persistent, patient leadership in the common discovery of laws of managerial situations which impersonally compel understanding and conviction and attract desire and voluntary disciplined cooperation throughout the organization.

Leadership is not passive; it is an active composite ability to induce (not impose) understanding, conviction, desire and action in a manner which leaves no disturbing impression of the mechanics of the induction. Every executive is a leader of a sort, but successfully to achieve a development of scientific management in an enterprise he must be that type known as a creative leader; one under whose leadership "those purposes and objects will find most ready reception at the hands of those led which can most readily be seen by them to square with their own desires or with desires which they can quite readily and naturally take up as their own."[1] As leader he must have energy, enthusiasm, imagination, intelligence, technical knowledge, knowledge of human nature, faith in people; and qualifying all of these, a special quality of sympathetic interest toward those led.[2] Not only must he manifest these characteristics in his relations with those major associate executives with whom he has immediate contact, but also he must inspire all of them to desire and learn how to become creative leaders in relations with their immediate associates. The more creative the leadership at the top, the more creative, although of course not uniformly so, will leadership become all along the line.

For the reason that in American industry most leadership at the top has been creative in the area of inception and promotion of enterprise, rather than in the area of organization of facilities and processes for economical achievement of components of the ultimate purpose—the natural result of a pioneer industry with its dominant sellers' market and environment of opportunism—there are not many cases of the all-round development of scientific management throughout the whole of an enterprise. Top leadership, which alone can initiate such developments, has not focused its attention on that problem.[3] But throughout American industry are many instances of the development of scientific management, under the leadership of subdepartmental executives, in the departments of an enterprise for which they have responsibility. While top leadership has been busy with creative

[1] Tead, Ordway, "The Nature and Uses of Creative Leadership," *Bulletin of the Taylor Society*, Vol. XII, No. 3, June, 1927, p. 398; and Tead, Ordway, *Human Nature and Management*, New York, McGraw-Hill Book Company, 1929.

[2] *Bulletin of the Taylor Society*, Vol. XII, No. 3, June, 1927, p. 399.

[3] For an example of creative top leadership, cf., Kendall, Henry P., "Scientific Management in a Textile Business," *Bulletin of the Taylor Society*, Vol. XII, No. 6, December, 1927, p. 519.

effort in the field of promotion and finance, departmental leadership has found its opportunity to become creative in that portion of the area representing organization of facilities and processes pertaining to its department. When in the course of time these departmental managers have carried their departmental experiences to positions of top leadership, transformation of entire enterprises will become more frequent.

We have considered leadership in its relation to executives rather than in its relation to workers, for the simple reason that in the development of scientific management the reaction of workers has not presented a serious problem.[1] To be sure, there was active doctrinaire opposition of the leaders of organized labor for a short period after 1910, and this opposition unquestionably generated a belief among the rank and file of workers that they did not believe in or want scientific management—*as abstractly defined* in the propaganda which was directed toward them. This opposition also made many owners and managers hesitant to undertake the development of scientific management openly, for fear labor controversy might result. But in specific instances when the development of scientific management under competent leadership has been undertaken in a plant, the *reaction of the particular workers concerned to the particular things undertaken* has generally been one at least of acquiescence, followed by approval as experience has given object lessons of its technique and results. The exceptional, unfavorable instances have been those in which the "Scientific Management" has not been genuine; has been essentially "the printing and ruling and unloading of a ton or two of blanks on a set of men and saying, 'Here's your system; go use it,' " [2] a procedure so characteristic of the "efficiency movement," which is in reality a travesty of scientific management and is abhorrent to its advocates.

That in specific instances workers should respond favorably to scientific management while the executive group presents serious obstacles, is perfectly understandable. The chief executive must necessarily present the proposition, to undertake the development of scientific management, to his associate executives, as a systematic whole—as a doctrine and complete body of procedures—because he is presenting a matter of future policy. It must be so presented to them because they must become the agents of its development, and as such they must comprehend it in advance in its entirety. The magnitude of the picture appals them and stimulates the active emergence of every mental and temperamental objection. They see that it means the upsetting of a complex set of procedures to which they are accus-

[1] Cf. Chapter XXVIII.

[2] Taylor, Frederick W., op. cit., in *Bulletin of the Taylor Society*, Vol. XI, Nos. 3 and 4, June-August, 1926, p. 102.

tomed; they envisage the ultimate aggregate of changes in a single picture, without realizing that the changes will come about only gradually and their adjustments will have to be made only gradually.

On the other hand it is usually presented to workers not as a doctrine, not as a complete system of which the details and consequences must be constructed in their imaginations, but, as successive small increments of procedure, one at a time, each of which is comprehensible, is demonstrated, proved out, and becomes familiar before the next is presented. Workers also by temperament and experience are more accustomed to respond to suggestion than are individualistic executives. In short, the executive group is difficult because scientific management must be presented to them as a philosophy, doctrine and inclusive system; the worker group is not difficult because the new methods are presented to it by increments each of which means a relatively small and comprehensible change.

It must be assumed in the present stage of industrial evolution that generally the normal organization of industry is one in which a capital-entrepreneur executive group must undertake ultimate responsibility for effective leadership in enterprise, and the worker group responsibility for effective "followship." Yet when considered in every detail the matter is not so simple as this. Any individual or group may under favorable conditions become an original and independent source of power and influence which causes it to assume some degree of effective if not nominal leadership. To the extent that scientific management substitutes the authority of the law of a managerial situation for arbitrary authority of an individual, and establishes functional responsibility and authority throughout an organization, it creates a situation in which many sources and varieties of leadership will develop. This has to an increasing extent come to be recognized in the procedures and in the doctrines of scientific management.

From the beginnings of scientific management it has been the practice of its technicians informally to rely upon those workers who have contact with the first increment of development of scientific management in a plant for contributions to the studies which result in standards and in control procedures, and for promotion of the idea among the remaining workers, and to prepare them for the later increments with which they will have contact. It is a very exceptional executive or engineer who does not proceed in this manner.

There are instances of executive leaders requesting worker leadership in a more formal manner. The following is illustrative.[1] In a certain plant the engineer had completed the preparatory work of standardizing conditions, equipment, tools and methods, and was ready

[1] Related to the author by Dwight V. Merrick.

to begin time study for the purpose of discovering standard times and computing standard rates. This was in a plant in which there was a company organization of the workers among whom, the engineer knew, there was an uninformed doctrinaire opposition to time study. Therefore instead of attempting to impose time study on the workers, the engineer consulted with the chairman of their executive committee. The chairman informed the engineer that the workers would never permit time study; that he himself was opposed to it. After explanations and discussion the chairman changed his attitude, but remained of the opinion that the workers as a group would never consent. "However," he said, "give me ten days to talk it over with the boys; in the meantime, forget it." About a week later he came to the engineer and said, "Go ahead; the boys are rather interested in trying it out." From then on the development proceeded with reasonable smoothness. Here was a case of good leadership by the engineer and good cooperating leadership by the chairman of the workers' organization.

Among not a few of the employers and engineers of the scientific management school the view is held that the workers' capacity for contribution to leadership should be utilized by formal provision of devices to serve as the instruments of such contributions. As early as 1914 Robert G. Valentine was propounding his theory of "consent," [1] and Robert B. Wolf, the principle, based on his own practice, of procedures to facilitate the utilization of the workers' capacity for creative self-expression,[2] in which principle was the germ of his later express statements that freedom of self-expression carries with it opportunity for leadership: "The management should primarily furnish the men with the information necessary for them intelligently to cooperate in determining what the standard practice should be . . . and my personal opinion is that the splendid results obtained by Dr. Taylor . . . were due largely to the fact that he stimulated the reasoning powers of the men . . . made them realize that they were cooperating in obtaining the results." [3]

In 1917 the author of this chapter argued that "it is expedient to match the workman's judgment against the manager's and the social scientist's, in order to obtain the benefit of the workman's unique advantages for judgment which in an increasing proportion outweigh his corresponding disadvantages." [4] Wrote Horace B. Drury, at about the same date, "We want all along the line not only men who can do what they are told to do, but men who can do things we would never

[1] *Bulletin of the Taylor Society*, Vol. II, No. 1, June, 1916, p. 7.

[2] Cf. *Bulletin of the Taylor Society*, Vol. 1, No. 3, May, 1915, p. 1; Vol. I, No. 4, August, 1915, p. 2; Vol. II, No. 1, January, 1915, p. 3.

[3] *Ibid.*, Vol. II, No. 3, June, 1916, pp. 7-8.

[4] *Ibid.*, Vol. III, No. 1, February, 1917, p. 5.

think of ourselves. We want men who have enough interest, and education, and experience and boldness, to make positive contributions to the intelligence and vigor of the work."[1] In which connection Morris L. Cooke observed in 1917, "Should we not learn in every relation in life to follow the lead of the particular individual who is charged with any given function, whether he be the President of the United States, the traffic officer, or the clerk in the office?"[2]

The development of this concept in scientific management had so progressed by 1924 that we find Henry S. Dennison declaring: "So if we use the word 'management' to describe these people who manage and then ask ourselves for a strict answer to the question, 'Who is management?', we must find ourselves forced to answer that while the managing factor is heavily graduated from almost zero to almost 100 per cent among separate individuals, it nevertheless finds itself to all practical purposes coterminous with the whole active organization. Incidentally it appears that the present intense interest in management showing through works councils or other collective devices is a more or less unconscious attempt to devise a method of getting the advantage of much more of the managing abilities in the total group than the old one man or autocratic structure could get. . . ."[3]

At a meeting of the Taylor Society in December, 1926, a paper by Miss Mary Follett emphasized this aspect of the doctrine of scientific management. "If, then, authority is derived from function, it has little to do with hierarchy of position as such, and in scientifically managed shops this is more and more recognized. We find authority with the head of a department, with an expert, with the driver of a truck as he decides on the order of deliveries. The dispatch clerk has more authority in dispatching work than the president . . . authority should go with knowledge and experience, . . . that is where obedience is due, no matter whether it is up the line or down the line."[4]

And in discussing Miss Follett's paper, Henry P. Kendall observed, "It has been my observation that the more progressive managers are practically trying so to organize the various functions of their business that department and staff men, functional men, will be as competent, or more competent, with reference to certain policies and decisions than the heads themselves . . . the successful heads of business today are doing less and less on major decisions—approving them but assuming less and less authority and responsibility—but doing more and more

[1] *Ibid.*, Vol. III, No. 4, August, 1917, p. 7.
[2] *Ibid.*, p. 7.
[3] *Bulletin of the Taylor Society*, Vol. IX, No. 3, June, 1924, p. 106.
[4] *Ibid.*, Vol. XI, No. 5, December, 1926, p. 243.

in the field of manning their organizations strongly and in the creative or inspirational field." [1]

In his presidential address before the meeting of the Taylor Society in December, 1928, Morris L. Cooke, discussing the possibility of a functional status for workers' organizations and expressing a growing conviction of a considerable proportion of the members of the Society, declared:

> If it can be accomplished the group of workers must be collectively related to industry in a way not possible under a bargaining status. What we want now is an integrating process which will tend more and more to unite us in a common purpose. The development of the techniques by which such unity may be accomplished is a problem common to all productive enterprise. . . .
>
> But the moment we suggest giving the grouped workers such a functional place in industry we are met with the statement that this necessarily means a divided leadership; and that leadership to be effective must head up in a single mind. . . .
>
> That the group has nothing further to do unless perhaps to secure the highest degree of cooperation on the part of each individual in carrying out the behests of the management and that the functional work of management does not need to be supplemented by the group, except as management using its own initiative may from time to time delegate to the group isolated tasks which in the opinion of such management may better be performed by the group than by management itself. . . .
>
> We really know very little as to how leadership is constituted—what is its true inwardness—and one may well question whether the interposition of the grouped workers in a place of responsibility and authority in management will detract an iota from its effectiveness. Most of us act under very serious misapprehensions as to the unfailing wisdom of management, the singleness of its purpose, and as to its being untrammeled in reaching its decisions. . . . When I consider all the agencies inside and outside a plant which measurably influence its management, I wonder whether we can actually delimit management in the sense that capital can be delimited. . . .
>
> With the development of finer disciplines on the part both of management and of the grouped workers, it may be possible to find ever-widening areas of functional cooperation, and this without withdrawing from management one iota of what is vital in its leadership. Possibly management has even more to gain from such a rapprochement than has the cause of the organization of the workers. . . .[2]

Apparently, therefore, the conception of leadership to which scientific management has developed is that of functionalized distribution of leadership as well as of execution—responsibility in leadership in accordance with specialized knowledge and capacity.

In addition to such leaderships as may come to individual workers in individual plants because of functional responsibilities there is evidence which gives reasonable warrant for the expectation of an attitude

[1] *Ibid.*, p. 252.
[2] *Ibid.*, Vol. XIV, No. 1, February, 1929, pp. 5-6.

toward scientific management on the part of labor organizations which promises a gradual acceptance by such organizations of a position of endorsement and leadership in its future development.

During the decade following the World War there has been, in the midst of general prosperity, a depression and considerable unemployment in many of the older basic industries. Even in some of the newer and more prosperous industries there has appeared a new type of unemployment resulting from mechanical developments, to which has been given the name "technological unemployment." Leaders of organized labor have been taking thought about this situation and are inclined to attribute it in large part to an inefficiency of management in the affected industries; not so much in the field of technology of invention and design as in the field of technology of adoption and use. These leaders are beginning to ask why they should not put pressure on industry for better regularization of employment. In their study of that problem they discover regularization of employment to be essentially a problem of regularization of operations; regularizing of operations to be a problem of management; any system of management which really regularizes, to be one which works through a control of all the factors of an enterprise; and that such a control must be based on standards discovered by research, investigation and experiment—in short, scientific management.

Specific consideration of a tendency for organized labor to assume leadership in promoting scientific management will be found in the last chapter. What such an outcome eventually would mean to the economic structure of American industry we leave to the imagination.

But whether or not this highly desirable doctrine is realized, it still remains true that in the increasing number of industries and companies where employee representation is an active force, the way is open for an education of rank and file in scientific management which executive leaders are already utilizing to marked advantage.

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Cf. Chapters II, XXVIII, and XXIX.

CHAPTER XXVIII

THE RESPONSE OF WORKERS TO SCIENTIFIC MANAGEMENT

1. Experience in a Non-Union Shop.[1] In 1917, the writer was employed at the Acme Wire Company, New Haven, Connecticut, manufacturers of insulated wire and electrical coil windings, then employing about 1,000 workers. There he received training through actual participation in the process of developing scientific management, and eventually he became responsible for the technical problems of standards, process engineering and control, involving refinement and further development of manufacturing and control methods.

This company was organized in 1904 and in 1917 had completed a period of extraordinary success, due partly to an exclusive patent privilege in one line of its business, partly to a practical monopoly in another line, and partly to a vigorous one-person general management. Over this period, however, because of growth and other reasons, these favorable factors tended to be neutralized, the company decided to secure the advantages of scientific management, and the development was begun in 1912 guided by an engineer retained for that purpose.

From the beginning there was an enthusiasm for scientific management on the part of owners and managers. The situation was unbalanced, however, because this enthusiasm of the managers was not matched by equal enthusiasm throughout the organization. For a long time the obscurity of certain results obtained, and the difficulty of showing other more obvious results, prevented this balance from being secured, and during that period the effects appeared to be detrimental.

The original shop organization was the old-fashioned "foreman do it all" type. The orders obtained by the sales department were first approved by the general manager and then a sufficient number of copies were made so that the stock room and each department affected received a copy. When these copies were distributed, the main office washed its hands of the transaction until a customer complained that he was not getting the goods. In the handling of the orders themselves the foremen had entire charge of the work in the shop. They ordered out all of their own materials as they thought they needed them. The operators kept track of their own times, usually waiting until morning to put down a record of the work done the day before. There was

[1] By Ernest G. Brown, Mechanical Engineer, United States Rubber Co., New Haven, Conn.

a complete absence of planning, scheduling, control and accounting in the modern sense of these terms.

At this point a little understanding of the nature of the manufacturing process is necessary for an appreciation of the decisions made at the beginning of scientific management, the effect, the consequent difficulties and the ultimate solution. The final result, too, is perhaps more interesting because the difficulties of development had a constant reaction upon the attitude of the workers.

The business was divided into two general parts, nearly equal: (1) insulated wire, consisting of copper conductor covered with enamel or cotton or silk; (2) electrical coils for meters, automobile starting and ignition systems, controllers, and so forth. The finished wire product (1) was the principal raw material for coil manufacture, although quantities of wire as such were also sold to other manufacturers.

The decision was made to begin the development in the coil division, not because it was the more logical place to start, but because it was at once more vital and apparently simpler. At the inception of standardization preparatory for rate setting, the purpose of scientific management was thoroughly outlined to the most reliable girl operator at coil winding, the first coil operation. This operator was immediately cooperative, and ready to help. (It is interesting to note that she later became instructor, then time-study observer, and is now in charge of all product-cost estimating, using standards cost accounting, in which position it is one of her functions to set standards of operating performance used generally throughout the plant.) The conditions under which work was done at her work place were standardized, stop-watch observations taken, a task fixed, and a bonus offered which the operator herself suggested as being satisfactory in amount for the effort expected. On the first day of operations under task and bonus the progress was followed constantly, and at the end of the day when the performance was completed with satisfaction to all concerned, a ceremony was made of the presentation of the bonus in specie right on the spot. The demand by the other operators for similar consideration was immediate and insistent, and development thereafter proceeded without any difficulty with the workers on these accounts.

An outline of steps taken at this time is contained in an officer's preliminary official report.

> Of course we took the skeleton of scientific management, consisting of the organized stock room; balance of stores; planning department with its functions of design, routing, time study and instruction cards and the bulletin board control of operations. This skeleton we took bodily and put it into practice and at the same time we had a complete audit of our books, and installed something

very like our present cost system. A purchasing agent was appointed and started on his duties; the whole factory was redivided into departments; the auxiliary functions more sharply defined and separated from the production. All this work was accomplished with a growth which has averaged almost a doubling of the shop every two years. A great deal of it, of course, would have been necessary whether we had scientific management or not, but I do feel, however, that scientific management enabled us to expand without the growing pains which we otherwise would have had.

Our engineering department, balance of work and production control are the most recent of these functions which can be traced to scientific management.

We have some concrete examples of actual reductions on specific jobs which the installations of task and bonus have enabled us to effect. The actual gains made when the standardizing of conditions had been completed, and task and bonus actually put into operation on the winding operation, on the type of coil of which we had the largest output at that time, was 120 per cent. When the superintendent who was in charge of the winding department, saw what the task on that coil was, he said not only that the operator to whom it was assigned would not make it, but that no human being could ever make it. It was rather interesting to know that the girl made the first batch without any trouble at all, and continued to do so until she was made instructor in the department.

That very fact led to the improvement in the output on other types of coils before any task and bonus had been applied to them. It was not very great, but it showed what could be done.

In the assembling work the gain was even more noticeable.

The company had not previously had a satisfactory cost system so it was not possible by comparison of new costs with old to measure accomplishment as these various things were done. It was unfortunate that this absence of adequate records covering the early period of growth led to a great desire for them, which resulted in a control system too fully detailed and a system of records much too complicated. The maintenance of these interfered with the efficient accomplishment of the workers' real tasks, and the dispatch, collection, recording and handling of them resulted in the growth of an overhead organization of unjustifiable proportions. The support of that overhead increased the load upon the direct production forces, and led to feelings of antagonism, chargeable to the overload of details rather than to the principles of scientific management. These details to a certain extent concealed the good effects obtained in other directions. There followed recognition of this attitude by the management through rate changes, alteration of method of wage payment, and shortening in the hours of work per week that properly would be classed as concessions to the workers.

Much of this effect was due directly to an overenthusiasm to have the development of scientific management completed expeditiously, because practically the entire plant, involving an extremely variable type of manufacturing, was included in the development before any

one division was really completed. To some degree this was a consequence of having an unusually satisfactory result with certain individual tasks worked upon in the beginning. But it was more directly the result of having started the development with the secondary rather than the primary operations.

In time all of these situations came to be recognized for what they were, both by the management and the workers. Eliminations and corrections were progressively applied, and rarely were any of these at odds with the principles set up in the very beginning. As a matter of fact all of the functions described in the officer's report, except bulletin board control, are still in effective operation. With these changes came final general acceptance of these principles by the worker group. A lack of standardization or a failure quickly to provide time study on new operations are now so insistently presented by the workers and their immediate supervisors that they represent a positive demand; notwithstanding the fact that the control operations are in the hands of a staff unit of the organization.

An interesting example of the real worth of this final attitude on the part of the workers is found in the recent experience with group bonus installation. As a result of the foregoing experiences a more deliberate start was made in one small, detached, department, and, after the advantage to the worker as well as to the company was understood, the work proceeded within the next few months through twelve large departments with marked success. This development required the workers to understand a whole new set of factors, for in many cases a single group involved more than a hundred individuals.

It is worth while to generalize to some extent upon the principles involved in this development, because it was not always smooth going, not always economical, although economies were constantly dominant, and the final result was possible largely because at each stage the workers were ready to cooperate in the measures decided upon by the managerial staff.

It was shown that before the actual demonstration of the advantages of the systems to be undertaken, the argument which carries real weight with the workers and their supervisors is that *the plan which delivers to them some share of the advantage accruing from its operation will be the only permanently successful one.* Indeed one may always be confident that any plan which gives all the benefits to either one side or the other is charged with the elements of inevitable failure.

The fixing of standards of equipment and process may in most instances then be done entirely without the worker's further cooperation. But that work will be better done with it than without it, and the fact of cooperation will tend to strengthen the position already

reached. In almost no case is it reasonable to suppose that the worker group is incompetent to contribute details of value to a plan new as a whole. The ready acceptance and recognition of such of these details as have merit will substantially improve the plan, their inclusion will lift its value in the eyes of those who are to operate it, and the whole outlook becomes progressively better.

At this stage accuracy is a prime essential. The nature of new management procedures will not permit their complete development by experimental application in the seclusion of a laboratory before they are thrust into the shop to stand on their own. Their original trial must be in the shop and in the presence of their critics, and the greatest pretrial guarantee of success is the intrinsic accuracy of the design of the plan and its execution. No factor is more powerful than measurable success from the start, and no result is more devastating than a failure that can be attributed to a neglect of facts and the necessary regard for accuracy. No group is more acute than the workers in detecting the failure of a procedure to conform to facts of actual operating situations.

In the case under illustration there was certain violation of the two factors of accuracy, and its essential accompaniment, deliberateness. It will be recalled that the development was undertaken on the coil manufacture, or finishing operation, rather than upon the preliminary wire manufacturing operation, because it appeared simpler to do it that way, and that the systems adopted were too detailed in technique. Experience proved that the development of the wire-manufacturing operations and their methods of control had such great bearing upon the use of wire as coil material at the later operation, that the coil-operating standards were necessarily under constant revision. This left the whole plant under development at once, a situation which ordinarily would not be attempted in large-scale, variable manufacturing to customer specifications. It was not until the preliminary wire operations were finally brought under control, involving the expenditure of several hundred thousand dollars for equipment of new design, that the full effect of the development was realized.

The development of new methods is of course a direct encroachment on the field of the immediate supervision of labor. If a foreman has had connection with a certain activity over a considerable period of time—and it is usually such an experience that partly entitles him to his position—a natural product of that association is the feeling that nowhere in the organization does there exist such a wealth of detailed knowledge concerning that activity as his own. If it is an old-time shop, such a feeling will have been fostered and strengthened by the plant managers, who assume that it is the function of a foreman to

know all about his department and to run it the one best way. Standardization of equipment and processes and subsequently time study within a foreman's department have to him the appearance of an appropriation of his prerogatives, because it has previously been his responsibility to care for equipment and in many cases also to act as "rate-setter." He will likewise so regard the removal of the control operations—routing, scheduling, and so on—from the shop to the planning department.

All these are indeed encroachments on an established relationship. But they are in the interest of a better result, and no real foreman will deny his interest in a better result. In the beginning it may and probably will be impossible to convince him of the desirability of the new plan in all its details. But if he is a good man, the natural challenge of seeing a better result attempted will incline him to give the new plan a chance. In fact, the foreman's advance reaction to these developments is a reasonably good index of his real ability.

Painstaking effort to develop an acceptance of principles on the part of the foreman and other supervisory agents of his rank is thus essential. Their good-will at the outset is a requisite, and preparations cannot be considered complete without it. For it must be remembered that in the eyes of the workers the foremen represent the management, and a front of unified approval of any plan contributes largely to its success even where other obstacles exist.

As already stated the foreman group at the Acme Wire Company did not originally have the same enthusiasm for scientific management development as the plant management. And this situation was made still more difficult because a cumbersome detail of system affecting the workers grew up, and the absence of previous cost records made impossible exact comparisons. But it was also shown in time that in the intermediate position between management and worker the foreman was often enabled to make suggestions which were helpful in matters of new technique.

The approval of the immediate supervisory groups will, therefore, add a substantial advantage to any plan with respect to receptivity of the workers. In the beginning stages the cultivation of a corresponding attitude on the part of the more progressive element in the labor group itself should be systematically undertaken and carried out. Eventually, through the issuance of routines, contact and experience all will know the purpose of the plan, but it is necessary to have them appreciate it as completely and as quickly as possible. Such a result is inspired by the sympathetic interest of those who, though workers, have established a natural position of leadership, as was well illustrated at this company by the first worker set to task, whose perform-

ance and leadership, already described, stimulated the entire surrounding group of workers.

In transactions of this sort it is also important to be concerned about the personal characteristics of those who carry to the workers the management's plans to institute new control methods. A person charged with such a responsibility naturally has the confidence and respect of the management whose delegate he is, but it is even more important that he be able to acquire and command the whole-hearted regard and respect of the workers who will be affected. Operators who like and respect a representative of management are less disposed to question his motives or criticize his plans.

The individuality of the worker must not be permitted to be submerged in the system. Assuming an original skepticism by reason of natural reluctance to change, it is but addition of insult to injury to impose upon the worker details of control procedure that cannot be fairly justified as suitable means to the end of getting productive work done. Unless caution is exercised here, there is danger that there may be a shift of emphasis to the devices themselves, as means of keeping the control plan operative rather than having it remain on the *purpose* of the devices—waste elimination, increased productivity and earnings.

At the beginning of the writer's experience with this development there were a hundred and twenty people in the central planning room, and fifty more in the cost department, all engaged with details that involved ticket handling by direct operatives. This handling was a great annoyance, and in after years it was amusing to recall that the operators, inspectors, and move men often cooperated in a wholesale disregard for batch numbers on the tickets issued by the control board. They would select any corresponding lot and go to work on it. As a result the bulletin-board clerk often spent two or three hours after the factory closed at night, moving lots around to positions which the bulletin board showed they should occupy. The real trouble was that the units of work were too small, and the workers disliked the annoyance and delay between lots. Now the planning department is reduced to ten people, payroll computation including bonus for the whole plant is done by one clerk, and the cost department on the old basis is entirely eliminated by standard cost accounting.

Proper recognition of the worker's abilities is essential. Since this can be done only to a definite limit by promotion in position, other methods have to be considered. An operator's reliability, interest in work, ingenuity in producing helpful suggestions, a willingness to be trained, and ability to perform a considerable range of related operations may all be recognized by differences from the base rate of pay established for a normal measure of these attributes. For an operator

to be able to perform half a dozen operations, each one requiring some training, yields a flexibility of facilities and an advantage to the management which, under the principle of the division of advantage, should be shared by both parties. There need be no difficulty in the existence of a variety of hourly wage rates on any job if the basis of its existence is understood and all may partake who qualify.

This experience stretching over a period of more than ten years demonstrates that so far as the workers are concerned, a plan of development will always proceed satisfactorily, provided it is designed to give as well as to take; is sufficiently deliberate in its introduction to permit understanding; is accurate in its detail, and not too cumbersome in its technique; and is presented by those who command respect and supported by a management which includes in its conception of scientific management a readiness to make changes whenever new and better ways are found and a willingness constantly to find those ways.

Under these circumstances the experience at this plant, as well as with intimate observation of other similar situations, leads the writer to the firm conviction that workers are not fundamentally opposed to the principles and procedures of scientific management, but are, on the contrary, naturally responsive, appreciative and truly cooperative.

2. Experience in a Union Shop.[1] The early developments of scientific management came at a time when there was generally a marked distrust of management by labor. The mass solidarity of labor and instances of concerted deception of management practiced by workers, so graphically described by Taylor, were an inevitable consequence of management's attitude toward labor—an attitude which assumed labor to be a commodity, governed it arbitrarily and by rule of thumb, believed that labor should produce what it could be forced to produce, but should be allowed to earn no more than a prevailing standard of wages, and cut piece rates ruthlessly if higher earnings resulted from stimulation of exertion. The natural reaction of workers was one of resentment and resistance, which frequently in union shops took the form of strikes if protests bore no fruit, and in non-union shops took the more subtle form of sabotage.

Appearing in the midst of such conditions—as a protest to these attitudes of both management and workers and as a remedy for them —scientific management experienced the opposition of both parties, as was bound to be true of anything new which challenged the current assumptions of both. The opposition of management to the technique has gradually been overcome, as is evidenced by the fact that scientific management has become the effective basis of all good management

[1] By Dr. N. I. Stone, Industrial Counselor, New York; formerly General Manager of the Hickey-Freeman Company, Rochester, N. Y.

throughout American industry; although survival of management's opposition is still apparent in the fact that many plants which have been revolutionized by scientific management refuse to acknowledge the source of the revolutionary influence.

If such has been the attitude of management, it should not be surprising that the attitude of union leaders toward scientific management was at the beginning and for sometime thereafter, positively hostile. Without special investigation of its mechanisms and their consequences for workers, union leaders denounced it as a doctrine and a system of practice. The American Federation of Labor under the leadership of the late Samuel Gompers assailed the introduction of the system in the government navy yards and succeeded in having the Congress specifically prohibit the use of the stop watch and all that went with it in the government plants. It is only in the past few years, toward the end of Mr. Gompers's life and especially since the accession of Mr. Green to the presidency of the American Federation of Labor and the stressing of the "human engineering" point of view by leaders of the Taylor Society, that a general appreciation of the broader aspects and the social benefits inherent in scientific management has gained ground and produced a profound change in the attitude of the leading spokesmen of organized labor in the United States.

It was against this background of general suspicion of and hostility to scientific management that the writer made his first attempt to introduce it in the clothing factory of the Hickey-Freeman Company in Rochester, New York, employing at the time about 1200 workers in a modern plant. Not only was it necessary to take into account the hostile assumptions of the workers, but the management had also to be convinced of the desirability of the change.

The officers of the company were frankly skeptical, willing to be shown but ready to discard the new system unless it proved to be a decided improvement over the old and well-tried system which, no matter what its theoretical shortcomings might be, had enabled the company to grow and prosper over a period of some twenty years.

The foremen, with one exception, were openly in arms against the new system; partly from a natural conservatism of men who had grown up under the old régime and knew only one way of running a shop, and partly from a feeling that their authority over the workers and security of position with the firm were likely to suffer as the new management succeeded in introducing a system in which they would be playing the part of novices.

It was therefore necessary to proceed with extreme caution and to take account of the psychological situation. The greater part of the first year of the writer's incumbency as labor manager of the company

was spent in consolidating the relations between the company and the workers as well as their union. The writer's appointment as labor manager coincided with the official recognition of the Amalgamated Clothing Workers of America by the employers. This recognition came about as a result of negotiations without resort to strike, and the employers felt that they ought to derive some benefit from the resultant good-will. On the part of the union and its members there was a feeling that after the many years of comparatively low wages prevailing in the clothing industry of Rochester they were entitled to tangible benefits from the new order of things. The recognition of the union was signalized by a general increase in wages and a reduction of hours to forty-four per week. This took place on April 1, 1919.

The year that followed marked the culmination of a period of unusual business activity and extraordinary demand for labor which resulted in great increase of wages even in non-union plants as the only means of retaining the services of their help. The unionized clothing industry of Rochester felt the effects of the general situation and two general increases of wages followed the one granted April first. In addition to the general increases of wages there were numerous increases of wage rates for individual workers paid by the week, which they were able to exact by claiming that they were offered higher wages elsewhere because of the prevailing shortage of labor. These cumulative increases resulted in advancing the wages of Rochester clothing workers from 50 to 100 per cent in less than one year. But they coincided with an equal if not even greater increase in the cost of living so that they failed to satisfy the workers who were constantly demanding more. The enormous increase in labor costs, coupled with similar increases in the cost of cloth and other raw materials, resulted in a corresponding rise in the price of clothing which forced consumers to economize, leading finally to the famous "buyers' strike." The first rumblings of the approaching storm were beginning to be heard.

It was at such a moment that the workers received their first introduction to scientific management in the Hickey-Freeman plant. The writer knew that the first steps in the process would be viewed by them with particular apprehension and suspicion, and that the only way to disarm suspicion and secure cooperation was to show them in unmistakable manner that they would be the first to benefit by the change.

As soon as the dispatch station was ready for operation, the writer addressed the workers of that shop. He pointed out to them that repeated increases in wages without a corresponding increase in production were not benefiting the workers, as they were being offset by rising prices to which manufacturers had to resort to make up for the increased cost of production. The only way to break the vicious circle

was to bring about an increase in earnings through increased production, which would mean a lowering of production costs without which a reduction in the constantly mounting cost of living was impossible. The dispatch station and all that would follow it were intended to help increase production through elimination of waste of effort and materials, through insuring a steady flow of work, standardization of materials and methods of performing various operations.

Mere assertion would of course not go far with the workers and the writer was therefore careful to see that the first changes to which they would have to submit should have their compensating advantages, as the following illustrations will make clear.

Under the old system, work was distributed to the workers throughout the shop by the foreman and his assistant. The worker had no occasion to rise from his or her seat from morning to night as long as there was work to do. Under the new system each worker was given enough work to last about an hour and was required to take it to the dispatch station and receive a new supply of work. This would mean an hourly interruption in work and a loss of from two to five minutes. Piece workers accustomed to the old ways would most certainly object to the change.

Under the old system it was impossible to keep track of the time it took to do each piece of work either by piece- or week-workers. The dispatch system provided a convenient means for recording the time taken to do each piece of work whether it was paid for by the piece or by the hour. Both piece and hour workers would naturally object to this, as it would enable the management to "know too much" about the relation of time and output.

Again, piece workers were accustomed to do much as they pleased in the matter of attendance. They were not required to ring the time clock either on coming in the morning or leaving in the afternoon, since they were not paid on a time basis. Under the new system it was necessary and feasible to have a record of their attendance. This was going to make it possible for the management, for the first time, to know whether low earnings were due to short time spent in the shop or to other causes, and this naturally was not to the liking of the piece workers. These few illustrations will show that there were sufficient legitimate as well as illegitimate reasons for objections to the new system by the workers, and the writer set himself the task of offsetting them by definite gains to the employees.

One of the most fertile sources of loss of earnings to the piece workers was idle time caused by irregular flow of work. Under the prevailing system of division of work it took no less than 125 operations to make a coat. In a shop employing only 250 workers there will

be an average of two workers to an operation and there will be several operations employing but one worker each. The absence of one worker employed on such an operation will cause a deficit of from 50 to 100 per cent in the output of the shop on that one operation. As soon as the accumulated reserve of work in the shop on that operation has been used up, all work will have to stop on operations following the one on which the absent worker is employed.

Under the old system workers were accustomed to these interruptions because of lack of work, and the piece worker took it as part of the hazards of piece work, trying to make up for lost time by demands for higher piece rates. Under the new system of planning and dispatching of work the management expected to eliminate or to reduce to a minimum interruptions of this kind. However, it would not have been reasonable to expect the workers to share that expectation as they knew nothing about scientific management. All they saw were some of the obvious disadvantages to them, as indicated above.

It was therefore decided to offer the workers an improvement over the old order of things in the form of payment to piece workers for idle time. The new rule provided for payment at the rate of 65 per cent of the average hourly earnings of the piece worker. Under the old system, there being no time records for piece work, neither the worker nor the management knew accurately what the hourly earnings of piece workers were. In order that we might know it now, it was manifestly necessary for every piece worker to register the time of his arrival at and departure from the shop, and to have him report at the dispatch station when receiving and returning work, so that a record could be made of the time work was given out and received. Payment for idle time was something unheard of before—something that even the union had never asked for—and therefore it made a profound impression upon the workers. It was a concrete illustration of the benefits from the new system that accrue to the worker.

It called for a great deal of patience and faith in the new management, on the part of the members of the firm, for in addition to the great expense involved in the introduction of the new system, it now had to submit to a totally new item of expense in the form of idle time which in the first year amounted to several thousand dollars. It may be said in passing that the very presence of the item of money paid for idle time in the weekly shop reports served to act as a sharp reminder of the imperfections in management that caused idle time. At meetings of the production staff it served as the starting point for discussions of causes of idle time and means of their elimination. Step by step the factors interfering with the steady flow of work were attacked and eliminated or minimized as far as was possible, until payment for

idle time became so negligible as to be hardly worth noticing.[1] But it helped to draw attention to and to do away with numerous sources of waste which in the aggregate far exceeded the amounts paid the workers for idle time.

The loss of time caused by the hourly walk to the dispatch station was more than made up through the physical benefit derived by each worker from the hourly change of position from a sitting posture, the relaxation derived from the walk to and from the station, and rest from work. This average loss of two to three minutes, or about fifteen minutes per day, was found to be even more effective than the ten-minute physical exercises practiced in the middle of the afternoon in many modern plants. As a matter of fact, the records of output of both week and piece workers showed that not only was there no falling off of production, but that production actually increased under the new system, fully bearing out the expectations of the management.

One of the means of preventing idleness among workers through the absence of one or more workers on a certain operation, is to train each worker to do more than one operation. The old-time tailor could make the whole coat, but under the system of division of labor, each worker specializes in but one operation out of more than a hundred.

The writer shared the feeling generally prevailing among economists, sociologists, and social workers, that this extreme specialization causes great monotony in the worker's life from which he would be glad to find relief. Therefore when it was decided to provide training for employees so as to teach them to do more than one operation, no opposition on the part of the workers was looked for. In fact, the writer believed that the workers would gratefully embrace the opportunity of breaking the monotony of working at one operation all the time, the more so that it offered several economic advantages to them. To know two or more operations enabled the worker to earn more money while learning a new operation than the 65 per cent which he received while sitting idle; and it offered the worker greater certainty of employment with his present firm or greater ease of finding employment with a new firm when looking for employment; and he had the satisfaction of knowing that by being able to take the place of an absent worker he was thereby saving dozens of his fellow employees from temporary idleness and loss of wages.

One can therefore easily imagine the surprise of the management when it was found that the workers were strongly opposed to training in spite of the fact that they were paid while being trained. The reaction was a purely psychological one. Most of the workers to be trained were women. The repetitive character of each operation on

[1] It declined to one-fourth to one-half of 1 per cent of the payroll.

which they were employed enabled them to perform it almost mechanically with a minimum of attention and of mental concentration, leaving them free to carry on conversations with their neighbors to the right and to the left while going on with their work. Learning a new operation called for mental effort, hurt their pride in being placed in the position of novices or apprentices, and in general, upset a well-established mental, physical and psychic equilibrium which they hated to have disturbed. So strong was their opposition to being taught new operations that they preferred to sit idle even if not paid for idle time, rather than trouble to learn a new operation at the expense of the firm.

The difficulty was only partially overcome through persistent effort on the part of the management with individual workers. The majority clung to their old operations. The whole experience showed the profound difference in the psychology of mental and manual workers, and how wrong we are in assuming that the workers suffer from the monotony of their simple repetitive operations. The opposite appears to be the case. The nature of intellectual work is such as to require mental concentration, and if of a repetitive character, it becomes monotonous and therefore irksome, causing one to seek variety. Manual work, on the other hand, when once thoroughly mastered, can be done with almost no mental concentration, enabling the worker to dream or talk to his fellow workers, so that he is unconscious of monotony and prefers the rhythm of a repetitive operation to the mental effort which is required by changes in work.

From the foregoing account it will be seen that the workers' reaction to the introduction of scientific management called for much patience and tact. In spite of frank explanations of objectives sought, through talks to the rank and file of the workers and through conferences with union and shop leaders, and in spite of monetary advantages which the workers derived immediately upon the introduction of the new system, the hostile influence of a few aggressive leaders, whose suspicious natures and prejudices against management on general principles prompted them to see cunning traps in every advantage offered to the employees, was sufficient to arouse opposition at every step when difficulties inseparable from the installation of a new complex system in a busy plant arose from time to time. It took the better part of a year to overcome the workers' suspicions through the practical demonstration of the superiority of the new system and its advantages to the workers as well as to the firm.

Today, after more than eight years of operation, scientific management as expressed in planning and dispatching of work, time studies, written specifications of standards of quality, and concentration of production control through the dispatch system which relieves the fore-

man of a duty which formerly took most of his time and sets him free for supervision of quality for which he is best fitted, is so firmly and successfully established that its most pronounced critics both in the executives' and workers' ranks would not think of suggesting its elimination and going back to the good old days of "hit and miss."

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Cf. references to Chapters XXVII and XXIX.

CHAPTER XXIX

INDUSTRIAL RELATIONS[1]

INCREASINGLY with the years, the dynamic quality of Taylor's genius grows manifest. He was not only a trail-blazing pioneer in bringing the specifically manufacturing techniques under the dominion of inductive science, but what is less generally recognized, he reoriented the social sciences by bringing them to focus on the productive process as the mainspring of civilization. While Taylor was not a philosopher in the academic sense, while he was not versed in anthropology or psychology, he was led by his experience to accept without further analysis or explicit statement a fundamental conclusion of philosophy. He realized that the tools men use and the manner in which they use them control the formation of mental attitudes and habits. He assumed as true what men like John Dewey have demonstrated to be true; namely, that all of our fundamental modes of activity, marriage, art, war, our social and cultural institutions, "tend to be psychologically assimilated to the pattern developed in the (characteristic) vocation."

The beginning of scientific management, he repeatedly said, is a mental revolution. This is true not only of scientific management in the factory, but also of scientific management as applied to distribution, consumption, the individual and community life. The main vehicle of this mental revolution today is the machine as the typical expression of the scientific techniques. There is an old German proverb that says, "Der Mensch ist, was er isst," food makes the man; we know that it is truer to say that tools make both food and the man. What men are, the manner of life they lead, their habits, folkways, political and cultural institutions are in large part reflex responses to the tools they use in getting a living. Taylor brought the greatest of all the tools, rigorous inductive science, to bear upon the total productive process. All of our fundamental modes of activity today are visibly in process of assimilation to the psychological pattern determined by our use of inductive science as our major tool. Taylor's mental revolution is proceeding through industry out into the world.

Inevitably, as a pioneer in that period when American industry was receiving the first impact of engineering technique, Taylor throughout his active life was principally preoccupied with perfecting the mechanical conditions of scientific production, "since it is obvious that

[1] By Robert Bruère, Secretary on Industrial Relations, J. C. Penney Foundation, Associate Editor, *The Survey*, New York.

what labor can do all depends upon the nature and condition of its implements." Because of this preoccupation and the high-strung intensity with which he pursued it, and in the absence of other stimuli—for industry had not yet generated present social problems—his vision of the problem of industrial relations came to be enclosed by the walls of the workshop. From the time when, as engineer, he began to gather in "all the great mass of traditional knowledge, which in the past had been in the hands of the workmen, and in the physical skill and knack of the workmen" and to reduce it "to laws, rules, and mathematical formulæ," to his final attempts, as a propagandist, to lead trade unions and old-line manufacturers to understand the practical implications of scientific management, the main objects of his attack were "systematic soldiering" on the one hand and the management of "initiative and incentive" or "rule-of-thumb" on the other. His main concern was the discovery of laws governing elimination of waste and the maximum production of goods. This led him to limit his vision of "the great revolution in mental attitude" to industrial production. His passion for the perfection of the tools and processes of production tended to obscure even for him the larger social significance of his own doctrine of the surplus.

The revolution in mental attitude takes place, he said, when "both sides take their eyes off the division of the surplus as the all important matter, and together turn their attention toward increasing the size of the surplus until the surplus becomes so large that it is unnecessary to quarrel over how it shall be divided." This shifting of attention would, he believed, result in "the substitution of peace for war, of hearty brotherly cooperation for contention and strife, of both pulling together in the same direction instead of pulling apart, of replacing suspicious watchfulness with mutual confidence, of becoming friends instead of enemies." He was right in assuming that the surplus is the center of interest for both workmen and employers. But he did not stop to consider why this is so. One of the most remarkable facts of our time, in America particularly, is the transition from what Simon Patten called the deficit economy to the surplus economy. The notion that it is possible through science to produce a surplus beyond the needs of increasing population has begun to establish itself in the public mind only within the last decade and is measurably due to the large-scale application of the techniques which Taylor developed. The so-called classical economists based their teaching upon the assumption that population would always press upon the food supply, that there could never be a sufficient surplus to abolish poverty as the normal condition of the great masses of mankind. The Marxian economics are based upon the same fundamental assumption. The teachings of

religious leaders have been to the same effect. The characteristic mental attitude of all groups in our society has hitherto been determined by this deficit economy and its necessary implication that competition and strife rather than cooperation are the conditions of survival.

The conflict or hunting-age pattern which Taylor saw as peculiarly characteristic of traditional employer-employee relationships is older and far more far-reaching than mechanized industry. It is the result of the age-old struggle of the race with hunger. The methods which Taylor introduced were so successful in individual factories in creating a local surplus, and his doctrine of high wages and low labor costs was so effective in improving industrial relations in the workshops under his control, that he tended to see in high wages, high profits, and a fair price to the consumer the complete solution of all the problems of industrial relations.

But no one industrial establishment can live unto itself. The revolution in mental attitude which Taylor advocated cannot become socially effective until the entire community is secure, not only in its ability to create a surplus, but also in the equitable distribution of the surplus when created. For the conquest of a surplus is not the end but the beginning of civilization. It is the function of industry as society's main instrument in the struggle for existence to create a surplus; it is the function of government and of our cultural institutions to provide for such a distribution of the surplus as will raise the general standard of living and improve the quality of the race. The mental revolution must be carried beyond the individual plant, beyond the total industrial organization, until it embraces the mind of the entire community. Although it was primarily the phase of acquisition of the larger social surplus which Taylor emphasized, his very technique of acquisition, involving as it did common understandings and cooperation, carried with it a new technique of distribution and a new view of labor's status.

What goes on inside the factory is only one part of the problem of scientific management in its full meaning; the other lies within the life of the enveloping community. Important as are local shop rules and systems of wages, the common law and public opinion, together with the statutes through which the community gives expression to its unfolding objectives, not local shop rules or any system of wages, form the more important basis of industrial relations; for these are not merely relations between wage-working employees and property-owning employers as such, but are fundamentally relations between two groups of citizens who are equals in the sight of the law. The function of the modern science of industrial relations is not only to create harmony within the factory; its greater function is to give

practical effect to this doctrine of equality in civic rights and individual opportunities which underlies all democratic government.

For this reason any scientific system of industrial relations must begin with and end with the consideration of the labor contract not only as defined in the statutes and interpretations of the courts, but also as reflected in public opinion with respect to labor. The implications of the labor contract differ in different countries, just as the political constitutions and folkways differ; it will have a slightly different meaning for the citizens of England, or Czechoslovakia, or France, or Germany, or Italy, or Japan, from its meaning for the citizens of the United States. But its history and present status in America may be taken as reasonably typical.

The Labor Contract as the Basis of Industrial Relations. The thing which distinguishes the labor contract from all contracts involving property alone is that it expresses the state's concern in the workman as a human being and a citizen. This interest of the community in the wage earner arises from the fact that in modern democracies he is an enfranchised citizen and holds a status of political equality with the employer.

In earlier social stages when work was performed by a slave class—in Rome and Egypt and Greece; in present-day backward groups, such as those in Uganda and Thibet, where the workers are serfs; in Russia before the Revolution, in the southern United States before the Civil War—there could obviously be no labor contract as we use the term. Workers were then as much property as the goods which they produced. They were in fact a commodity, and the community which sanctioned their slave status had no special concern for them beyond the rudimentary humanity which would be accorded to a horse or a dog. In pre-enfranchised days the scope of industrial relations was limited by the Biblical command of a master to his servant, "Go, and he goeth,"—or take the consequences. There probably was a time long before society advanced even to the slave stage when each man was his own producer and consumer, when he made what he needed, if he knew how, and if he did not, either took it by force from some one who had made it, or got it by barter. Here the only labor contract was what a man set himself to do; the only industrial relations were those he had with himself.

But in a democracy where the worker is politically as free as the employer, the community is interested in his well-being as a citizen. It places restrictions not only upon the employer, but upon the worker himself in the public interest. It establishes health, safety, and other regulations within which industry must operate, quite apart from the will of either the employer or the employee in their private capacities

as producers. It not only restricts the employer from doing things that may impair the worker's value as a citizen, but it also strives by such regulations as the laws against child labor, night work for women, and limitations of hours for men in dangerous occupations, to prevent the worker's impairing his own community value.

The history of the labor contract in the United States is the history of the changing status of the worker, of his slow economic rise toward the level of his political status, of the community's increasing interest that he should rise, and its increasing part in helping him to do it. This has perhaps its best illustration in the history of workmen's compensation from the time when compensation for injury was an issue between master and servant, to the present time when, instead of a servant, the worker is a citizen entitled to a compensation which is a charge upon industry and through industry upon the whole community. Almost invariably employers first opposed these legislative restrictions respecting health, hours, wages, as they did the workmen's compensation laws, on the grounds that they interfered with the rights of private property, made industry unprofitable, and so prevented the creation of that economic surplus in which the community had a primary interest.

"If you interfere with us by passing such laws, we shall have to shut down, the workmen will have no jobs, and then where does all this fine talk about citizens and the community get you?" they said in effect. This was not a trumped-up objection on the part of manufacturers, nor a vain threat. The development of the labor contract as illustrated by Workmen's Compensation Laws had been largely brought about by forces outside of industry and uninformed on the technical complexities of the manufacturing process. Scientific management had not yet begun to determine the attitude of employers toward their own problems. That part of the community in which the humanitarian urge was strong focused its attack through social reformers, whom public opinion backed with the police powers of the state. Neither they nor the workers through their trade unions assumed any responsibility for the problems it caused management. Together the reformers and organized labor set about coercing or policing industry. America went through a phase of the class struggle in which social reformers were allied with the organized workers. As with workmen's compensation, so they fought other measures affecting the labor contract through the various state legislatures and the Congress, and gradually established a body of restrictive regulations within which management was compelled to operate. As these restrictions were established without the direct cooperation of employers as a group and frequently against the will of the employers, the question

as to whether they could be put into effect without endangering the economic surplus was a real one.

Enter Scientific Management. That the proponents of scientific management should first address the interest of employers was in the beginning inevitable. They had taken great pains to sell scientific management to the employers and one of the most effective of their sales arguments was that high wages would not only lower production costs, but would also free employers from most of the traditional harassments of labor-employer relationships. That industry could produce enough for all, Taylor had already demonstrated; that it could do this under the tightening restrictions of social legislation had still to be proved.

As to shop conditions, for example, there is no word in Taylor's writings about the need for making the workshop a fit and pleasant place for men to work in. In his "On the Art of Cutting Metals" he lists as one of his discoveries the high advantage of supplying water to cutting tools. Nowhere in Taylor's writings is there any reference to that whole range of problems which is concerned with supplying the workers with safety, or cleanliness, or good lighting, or any of the things which come within scope of industrial hygiene. Because of his preoccupation with the mechanical equipment, Taylor inevitably thought of the workman almost exclusively in terms of skill, application and production, rather than in terms of personality. In saying this, I want very particularly to avoid the impression that Taylor was lacking in a sensitive regard for the men with whom he worked. We must be historically minded and recall that his books were written twenty-five to thirty-five years ago. The pioneering idea was still strong upon the American community. To be able to do the day's job under rough conditions was a test of the manly virtues. Taylor asked nothing of the least of his workmen that he had not asked of himself. In his lecture "Success," nearly all of the illustrative incidents of young men's ability to meet and solve the day's problems in the face of obstacles were his own earlier experiences disguised. Clinical psychology and the social sciences had not yet begun to explore the inner nature of man, or to reveal the conditions under which that nature might function most effectively. In his testimony before the Committee of the House of Representatives, Taylor repeatedly used horses to illustrate his standards for the evaluation of workmen. In his pig-iron experiments he insisted that the best man for that particular purpose was the ox-like man. While he insisted that the beginning of scientific management is a mental revolution, his illustrations unhappily convey the impression that in wide ranges of the production process he preferred the workman who was incapable of

any independent thinking at all. "Now one of the first requirements for a man who is fit to handle pig-iron as a regular occupation," he wrote in *The Principles of Scientific Management*, "is that he shall be so stupid and so phlegmatic that he more nearly resembles in his mental make-up the ox than any other type. . . . The workman who is best suited to handle pig-iron is unable to understand the real science of doing this class of work. He is so stupid that the word *percentage* has no meaning to him." [1] When he found his ox-like man, he does not seem to have asked, "How did this man get this way and is not his ox-likeness an indictment of our whole social, educational, and industrial system?"

Toward the end of his life Taylor himself gave up the use of this figure of speech, because it tended to convey a false impression of his genuinely humane attitude toward his workmen. I do not revive it here to indict Taylor's motives, but only to reveal the spirit which dominated industrial relations at the time when he was doing his great work. It was assumed that ox-like men existed, as it were, by the will of God or by the laws of heredity, and that the best service one might render to them was to adjust them to efficient performance of such work of that period as ox-like men were by nature equipped to do.

Taylor repeatedly said that he derived from workmen not only the great body of skills which he organized into his system, but also many major suggestions for its subsequent improvement. Yet he never took the career of this creative type of workman to illustrate his methods or achievements. Indeed, in his testimony before the Committee of the House of Representatives he asserted "without the slightest hesitation, that the high-class mechanic has a far smaller chance of ever thoroughly understanding the science of his work than the pig-iron handler has of understanding the science of his work." He failed to distinguish between a knowledge of details and that very revolution in mental attitude upon which he placed so much stress and of which workmen as well as managers are about equally capable. The result was that not only labor leaders but socially-minded people generally got the idea that scientific management aimed at the degradation of workmen into obedient oxen under the direction of a small body of experts—into men debarred from creative participation in their work, whose value was to be reckoned solely in terms of wages. Even those of us who know Taylor only through Copley's biography realize what serious injustice this indictment does to the great-hearted humanitarianism of the man. The driving force of his life was the conviction that all men could be freed from brutalizing poverty. And yet it is

[1] Taylor, Frederick, *The Principles of Scientific Management*, New York, Harper & Brothers, 1913, p. 59.

not difficult to see how his own statement might have inspired those trade-union objections to scientific management which were formulated by the committee especially appointed to represent the attitude of the American Federation of Labor before the United States Commission on Industrial Relations in 1914.

"Scientific Management," declared this committee, "is a device employed for the purpose of increasing production of profits and tends to eliminate consideration for the character, rights and welfare of the employees. It libels the character of the worker, it looks upon the worker as a mere instrument of production, it ordinarily allows the workman no voice in hiring or discharge, the setting of the task, the determination of the wage rate, or of the general conditions of employment. In spirit and in essence, so far as labor is concerned, it is a cunningly devised speeding up and sweating system." [1]

Had Taylor lived, the logic of his own techniques would undoubtedly have led him on to a thorough consideration of all these problems of individual and group psychology as matters of high importance in themselves and having a controlling effect upon economically and socially efficient production. For this his life was too short. As a matter of fact it was the Taylor Society which took up his educational work, that enlarged the perspective; that for instance gave to Robert G. Valentine the forum from which he made his appeal to the more orthodox of the scientific management engineers to include all these measures for the development of the individual in industry within the sphere of their professional activities. While Valentine approached the problems of management primarily from the point of view of the social reformers and the trade unionists, his great contribution was his explicit recognition of scientific management as the essential instrument for integrating the social with the economic motive in industry. He therefore urged the foremost of Taylor's disciples to see these problems of individual and social well-being as properly within the range of their own techniques; to recognize that they are essentially problems of scientific management itself and that their solution within industry is essential in the long run to the development of the highest productive efficiency.

As contrasted with Taylor's natural and compelled preoccupation with the mechanical equipment, Valentine was principally concerned to know what the conditions are under which all parties to the production process and more particularly the workers can most fully realize their own potentialities, not only as workers, but as citizens and human beings. He therefore proposed to audit working conditions, both in-

[1] Hoxie, Franklin Robert, *Scientific Management and Labor,* New York, D. Appleton & Company, 1915, pp. 15-19.

side and outside the factory—the arrangement of spaces for comfortable work, hygienic working conditions, sanitary equipment, right lighting, wages in terms of living standards instead of in terms of the prevailing market rate, which was Taylor's starting point. Valentine's labor audit was the most conspicuous contribution to the development of the technique of industrial relations since Taylor's work at Midvale. It does for labor in industry what a financial audit does for its capital factor. It shows the conditions under which labor functions most effectively. It appraises the immaterial forces that affect labor relationships, such as beliefs, legislation, public opinion, the objectives of labor and employer organizations; the returns to which labor is entitled, not only directly in the form of wages, but indirectly in provision for the future, including recreation and education. The labor audit brought within the range of managerial consideration a whole group of factors which Taylor and his immediate followers had not taken into account in their expositions and it sought to define them in terms of scientific management itself.

The classical example of Valentine's attempt to widen the reach of Taylor's mental revolution is his paper on time study,[1] which he had been invited to prepare by the Taylor Society. Valentine argued that Taylor appeared to have conducted his time studies as a laboratory researcher would study the motor reactions of frogs or fish. He argued that the workers through their independent organizations should be parties to the development of the time-study techniques. He believed that the participation of the workers more especially through their independent organizations had a functional value not only from the point of view of the economic advantage of the individual establishment, but also from that of society at large. "Our immediate task," he told the Taylor Society, "is to see whether we can begin at the present time to get a line on that genuine application of the principles of scientific management which is beneficial to society, as against that alleged application which is dangerous to society. . . . The standard by which to judge is to ascertain whether any particular application of the principles involves the recognition of a truly independent and organized consent on the part of the workers. . . . The days of compulsion, the days of service without consent are over. . . . We find, however slowly and haltingly through the decades, a steadily increasing assertion of the right, both of the individual and of the individual in groups to give his consent to that which from any other human quarter it is desired him to do. . . . I think there will be little doubt among any of us as to the general proposal that a free man—a consenting man—

[1] Valentine, Robert G., "The Progressive Relation Between Efficiency and Consent," *Bulletin of the Taylor Society*, Vol. II, No. 1, January, 1916, pp. 7-20.

is the more desirable worker. Where we have broken down in imagination is in failing to realize that organized consent as well as individual consent is the basis of a more efficient group. We have been accustomed too much to think of democracy as almost necessarily a mere crude expression of untrained opinion through votes. Almost nothing has yet been attempted to build up a final texture of democracy through self-training groups, constantly growing in strength through the consideration of scientifically accurate data." [1]

Also in the same year that Valentine was invited to expound his ideas of consent before the Taylor Society, this society invited Robert B. Wolf to use its forum for exposition of his ideas of creative participation by workers.[2]

Valentine used the word "consent" to express what he regarded as a "right" inherent in the status of an enfranchised worker-citizen. It remained in turn for certain of Taylor's most ardent disciples to develop this conception of consent in terms of function. Mr. Morris L. Cooke, for example, who got his training under Taylor and who has twice served as president of the Taylor Society, in his study *Morale as a Factor in Time Study Technique,* demonstrates that consent, not so much as a right, but rather as the outcome of enlightened participation by the workers in the development of time-study procedures, "has become precedent to the proper practice of time study and to any reasonably accurate determination of production standards for the individual." [3]

Like Valentine, he insists that this participation is ineffective if limited to the individual. He regards it as a group function. Indeed, he does not stop with the smaller groups directly concerned in any time-study determinations, such as those of a department in a factory, or even the total working force in any individual factory. "Further progress in establishing the art and science of time study," he says, "will become more and more dependent upon morale interpreted as the state of mind not of one group, but as the totality of attitude resulting from those various groupings and regroupings through which we members of the human family are related to any given undertaking." [4] Taylor's revolution in mental attitude, to be effective, cannot stop short of the organized community.

This led Mr. Cooke in a subsequent study, read before the Taylor Society, in December, 1928, to the conclusion that collective bargain-

[1] *Ibid.,* pp. 8-9.

[2] Wolf, Robert B., "Individuality in Industry," *Bulletin of the Taylor Society,* Vol. I, No. 4, August, 1915, pp. 2-8.

[3] Cooke, Morris L., "Morale as a Factor in Time Study Technique," *Bulletin of the Taylor Society,* Vol. XII, No. 2, April, 1927, p. 331.

[4] *Ibid.,* p. 333.

ing on a national basis is in the interest not only of the workers, but also of society, including employers; and that "if labor organizations are in fact desirable social agencies and essential to the orderly conduct of industry, they logically come within the field of management and industrial engineering. It therefore becomes a part of our task to discover all necessary outlets for the energy and spirit of the grouped workers and to aid in the cultivation on the part of management and labor of those newer disciplines which will effect the maximum cooperative effort. . . . As professional management engineers, should we not include within our field the development of those techniques by which the various organizations of the workers can be given a place in the industrial process consistent with all that science is in that way of contributing to industry?" [1]

A foremost disciple of Taylor, some twenty years after Taylor had prophesied that scientific management might remove the need for trade unions, thus contends that Taylor's mental revolution cannot be effective until it embraces the intelligent participation not only of managers and individual workers, but of all groups concerned in the industrial process—employers' associations, trade unions, the public—in establishing the structure of government of industry. As he visualizes the future, the labor contract, written and unwritten, will recognize the workmen, as creative participants with the experts in developing and applying the scientific techniques to the whole range of problems involved in the conduct of industry. Scientific management has thus manifested its possession of fundamental values which meet and adjust to the changes in social outlook and philosophy developed in industrial experience.

Illustrative Cases. The evolution of the controlling ideas underlying industrial relations which I have just traced is not a matter of theory only. It is finding numerous interesting examples in current American practice. The two forces which have been most effective in reconstructing the bases of the labor contract—public opinion, as illustrated, for example, in the history of workmen's compensation, and inductive science as developed by Taylor—may be seen in process of integration both in certain company union factories, and among others in the men's clothing industry through cooperation between a national trade union and the men's clothing manufacturers. I have therefore chosen two representative examples of this activity, one in relation to company unions and the other in relation to labor unions.

In the Sperry Gyroscope Company, the sustained application of the scientific method to the problems of industrial relations was a by-

[1] Cooke, Morris L., "Some Observations on Worker's Organizations," *Bulletin of the Taylor Society*, Vol. XIV, No. 1, February, 1929, p. 2.

product of the restrictions imposed by the State Workmen's Compensation Law. The cost of insurance to meet the requirements of the law varies with the accident frequency rate. The work in the Sperry factory was not unusually hazardous, the factory itself was modern in type—clean, well lighted, spacious—and yet under the régime of unscientific master-and-servant benevolence the accident rate went as high as forty-five per thousand employees in a single month. Under the pressure of the resultant high-insurance costs, the management began to analyze every accident to get at its cause and to devise means for preventing its recurrence. Mechanical safety devices were introduced, machines were better arranged. But these mechanical devices proved inadequate. It became necessary not only to instruct individual workers in methods of safety, but to win their active participation as a group in the development and use of such methods. The workers were invited to create their own committee on safety to cooperate with the management in the perfection of scientific accident prevention devices and techniques.

The Sperry Company found what Mr. Cooke discovered in developing time-study procedures, that the prevention of accidents is fundamentally a problem of group morale, of an inclusive revolution in mental attitude. Enlightened participation of the workers in the development of scientific practices is not only essential in terms of economic efficiency, but is equally essential in protecting them from bodily injury and mental stultification.

The Sperry factory has undergone a similar evolution in its methods of employing men and of establishing wage rates. In the old days when the management needed additional labor, the foreman went down to the factory gate, where a miscellaneous company of applicants kept an eye on the weather. "Any good all-round machinists or pattern makers looking for a job?" he shouted. If jobs were scarce, most men would answer "yes," whatever their previous experience. The foreman would look them over, trust to his ability to size up human nature and pick out what he wanted, as bargain-hunting women buy antiques at an auction. Sometimes his hunch was right, sometimes it went completely wrong. Then followed haggling over wages, "giving 'em Hell" for spoiled work, the walking delegate perhaps, or a departmental strike.

In due course this method was recognized as both humanly wasteful and inefficient. When a foreman needs to replace a worn-out part of a machine, or if he needs new parts, he sends precise specifications to the stores department. So today in the Sperry factory a foreman needing a workman sends to the employment division of the personnel department precise specifications of the job to be filled, and

on this basis the employment supervisor interviews applicants and makes intelligent selections. In the determination of these specifications, as in the determination of the wages to be paid for particular work, the employees as a group are now invited to participate.

For example, the members of one of the craft groups raised the question, "Why should we get less money than the men in another division who do no finer work than ours?" Thereupon the management raised the larger question as to whether the company could afford any wage increases. Instead, however, of assuming that no increases were possible and arbitrarily refusing to consider the first questions raised by the workmen, the company opened its books to a committee of employees. They agreed that earnings did not then warrant a general increase, but they did not stop at this point as the managers in acting alone might have been disposed to do. They raised the further question as to how the total money allocated to payroll might be more equably divided among all employees. Each occupation was subjected to a critical analysis which resulted in its segmentation into fifteen parts. A committee of executives made independent ratings and then combined their opinions. A committee of workers made a similar schedule of ratings. The two groups were amazed at the close correspondence between their separate appraisals, item by item and for occupations as a whole. There was complete agreement on the functional validity of the fifteen items used to appraise the relative values of the occupations; and the rates independently assigned to each item by the two groups corresponded so closely that the composite ratings were promptly accepted on both sides. And when these scientifically determined rate scales were applied to the examination of rates actually being paid, a surprising fact came to light. Some of the most competent workmen who happened to be of a self-effacing disposition were found to be receiving lower rates than less competent workmen who, being of a more self-assertive temperament, "hollered louder." When the inductively determined rating standard took the place of haggling and lung power, a number of the diffident workers received rate increases in some cases as high as 27 per cent. As with the prevention of accidents, the joint application of the scientific method developed a group morale with respect to wages and their relation to work performed which proved highly advantageous to all concerned.[1]

But because the Sperry Company operates a company union and has no cooperative relationships with national trade union organizations, the influence of its industrial relations procedures is limited to its own establishment. It has made no notable contribution to the

[1] Lott, M. R., *Wage Scales and Job Evaluation,* New York, The Ronald Press Company, 1926.

raising of standards in the machine industry to which it belongs. This is in contrast with the development in the men's clothing industry, where through the nation-wide cooperation between workers and employers the tendency has been to raise the level of the entire industry to that of the best among men's clothing factories.

The history of the men's clothing industry offers a striking illustration of the evolution of the controlling ideas in industrial relations from the beginning of machine industry and mass production to the present. The sewing machine came on the market about 1850. Before that time all tailoring was done by hand and industrial relations were those of master and servant, characteristic of the domestic handicrafts. The Civil War gave the first great impetus toward standardized factory production in this trade. For fifty years thereafter men's clothing factories multiplied and the industry became notorious as the breeder of sweat shops. The public consequences of the extreme exploitation of cheap immigrant labor provoked a number of the most notable social reform movements in nineteenth-century America.

Certain of the labor leaders of the period outdid the employers in fleecing the workers. Time and again the rank and file appealed to socially minded citizens to save them from the evils of an industrial situation which they themselves were incapable of controlling. After many years and largely with the aid of social reformers, who organized public opinion on their behalf and secured a series of protective laws on the grounds of public interest, the workers slowly established their own trade unions.

Originally in their attitude toward the employers they were militantly defensive. The Marxian doctrine of the class war found its place in the preamble of their constitutions. Today, having united in a nation-wide industrial union, the Amalgamated Clothing Workers of America, as a coordinate group with the employers in the various markets in which the industry flourishes, have adopted and developed a policy of cooperation which is yielding extraordinarily significant results. The initiation and establishment of this policy was largely the work of Joseph Schaffner of the firm of Hart, Schaffner and Marx in Chicago, who for eighteen years, especially through their labor manager, Earl Dean Howard, have cooperated with Sidney Hillman, who from 1910 to 1914 acted as the workers' deputy in negotiations with this firm and since 1914 has been president of the Amalgamated Union. The institution of the impartial chairman with all the related procedures of constitutional government at first established under the joint auspices of union and management in the factories of Hart, Schaffner and Marx, gradually spread throughout the Chi-

cago market and in due course through all the major men's clothing markets of the country.

Just as scientific management carries within its technique the necessity of cooperative good-will, so joint effort to improve working conditions involves a call upon the technique of scientific management. The principles of scientific management are gradually being applied to production under the joint auspices of management and workers in the men's clothing industry. There have been instances where management has turned over the conduct of entire departments to the union. In one notable case the union has operated an entire factory, supplying finished products under contract with the manufacturer. This participation of the workers in the problems of management has not resulted in divided authority; rather it has resulted in creative cooperation between groups, each of whom look upon themselves as partners in a common enterprise.

In reviewing the history of the Amalgamated Clothing Workers Union, Sidney Hillman defined and explained this relationship. "We built our organization," he said, "on a more solid and more concrete foundation, because we were not guided merely by selfish interests. We approached our task not as outsiders, but as partners to whom the condition of the industry as a whole is of paramount importance. So it was not a matter of merely securing a better wage that we put before ourselves; we were out to eliminate chaos and arbitrary rules and substitute constitutional government. And it is no boast that the first decade of the operation of the Amalgamated has proved to be of great educative value to the men's clothing industry." [1]

Here as in probably no other industry in America has that spirit of cooperation, which was Taylor's objective, been established on a nation-wide basis, not through scientific management as a function of management alone, but through that participation of the workers with management in the development and application of the scientific disciplines which President Cooke of the Taylor Society urged upon his scientific management colleagues.

As a result of this development in the men's clothing industry, through which the union has been recognized as a partner having specific functions to perform, strife has largely disappeared as the normal characteristic of industrial relations. And the creative energies of both manufacturers and workmen have been released for raising the economic condition of the industry and the social standard of the workers as citizens of the community. The union operates the employment exchanges for the industry. Together with the employers

[1] Hillman, Sidney, "1914-1924: A Retrospect," *The Amalgamated Illustrated Almanac*, 1924, p. 30.

it has established a system of unemployment insurance. On its own account it has opened up highly successful banks, through which in addition to many other services, it has taken the leadership in the building of model homes for trade unionists.

The philosophy behind this far-reaching economic and social program President Hillman once summarized by saying that in his opinion that form of labor organization would survive which functioned most satisfactorily in the interest not only of employers and wage workers, but also of the community for whose service industry exists.

In tracing the evolution of the labor contract as the basis of industrial relations, I have had to travel far afield from the point at which Taylor made his attack upon systematic soldiering and the management of rule-of-thumb as the roots of all industrial evils. And in thus traveling far afield there is much territory which has, because of limitations of space, been left unnoticed. Short of that ultimate test of the soundness of industrial relations—the nature of the labor contract—are many aspects of employer-employee relations on which scientific management has had a profound influence. Most of these have been incidentally indicated in preceding chapters of this book. The whole range of personnel activities—including selection, assignment, training, health and safety, joint negotiations over work and pay standards, and all the rest, now widely used in American industry, also evidence an application of scientific outlook toward technical human problems. So also with respect to stabilization and regularization of employment. Taylor's influence is to be seen in this whole development since it meant an objective and measured approach to the application of human energy precisely as much as his own original work required science in the application of mechanical energy. And as every current study of personnel work in business has shown, the sweep of this humanizing influence has included literally hundreds of factories, stores and offices in which personnel work carries on and in which some increasing measure of group consent and creative participation is an integral part of the picture.

Taylor's generation, it seems to me, did not, because relations were then not so complicated, sufficiently take into account the extent to which all of us are creatures of our total environment. For him the workshop was not only the center of the universe; it was his world. He took little account of those great intangible forces that engender social reform movements—and in extreme cases—political revolutions. It is as easy to point out his limitations today as it is for biologists to note those of Darwin. Yet the fact remains that had he not shown how the rigorous methods of inductive science can be applied not only to the creation of an economic surplus, but to the rational integration

and control of all the dynamic elements involved in the production process, our social reform movements, including the mass movements of labor, might have led to confusion and vast disorder instead of physical and measurably controlled progress.

He was profoundly right in his contention that the beginning of right industrial relations was the shifting of attention from the division of the surplus to the creation of a surplus so large as to minimize the occasion for quarreling over its division. The techniques which he was the first systematically to apply have had a profound influence in shaping the energies of management and workers alike into channels of orderly creative activity.

Largely because of his work, industry today is the most effective of our educational institutions so far as the scientific disciplines are concerned. For with respect to the great masses of our working population, it is only in industry that they come directly under the influence of the authentic scientific tradition. Whatever the limitations set by the brevity of one man's life upon his practical achievement, Taylor, by opening the doors of industry to science, not only revolutionized the specific techniques of production, but also prepared the way for the application of the methods of science to the whole range of problems which we today include within our conception of personnel management and industrial relations.

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